

# SYNLETT Spotlight 132

## Trichloroisocyanuric Acid (TCCA)

Compiled by José C. Barros



This feature focuses on a reagent chosen by a postgraduate, highlighting the uses and preparation of the reagent in current research

José C. Barros was born in Rio de Janeiro (Brazil) in 1978 and studied chemical engineering at Instituto Militar de Engenharia (IME). After spending a year in France at Ecole Nationale Supérieure de Chimie de Clermont-Ferrand (ENSCCF), he decided to continue his studies of organic chemistry. He is currently working toward his M.Sc. at Universidade Federal do Rio de Janeiro (UFRJ) under supervision of O.A.C. Antunes and J.F.M. da Silva on the synthesis of HIV-protease inhibitors.

LAB 641 – Centro de Tecnologia - Bloco A - Instituto de Química, Universidade Federal do Rio de Janeiro, C.P. 68563, Rio de Janeiro, CEP 21945-970, Brazil  
E-mail: zerozero43@yahoo.com.br

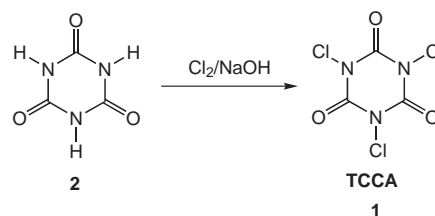
### Introduction

Trichloroisocyanuric acid (TCCA) is a stable and inexpensive industrial chemical usually used as bleaching agent and bactericide.

It has found applications in organic chemistry as a chlorinating agent or oxidant,<sup>1</sup> allowing thioacetalization of carbonyl compounds, conversion of alcohols to halides, carboxylic acids to acid chlorides, alkenes to chloroethers, N-nitrosation of *N,N*-dialkylamines, selective mononitration of phenols, oxidation of alcohols to carbonyl compounds, aldehydes to methyl esters, aldoximes to nitrile oxides, thiols to disulfides, selenols to diselenides, and sulfides to sulfoxides.

### Preparation

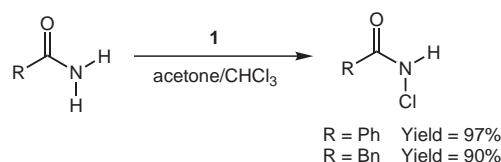
TCCA (**1**) is prepared by chlorination of cyanuric acid (**2**) with chlorine gas (Scheme 1).<sup>2</sup> It is readily soluble in organic solvents.



Scheme 1

### Abstracts

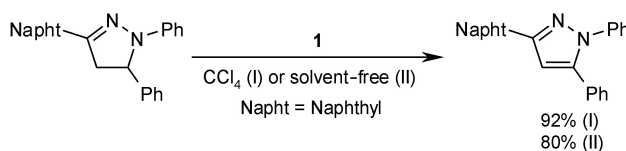
(A) Amides, lactams and carbamates of  $\alpha$ -amino acids can be easily transformed into the corresponding N-chlorinated compounds through reaction with TCCA, under mild reaction conditions.<sup>3</sup>



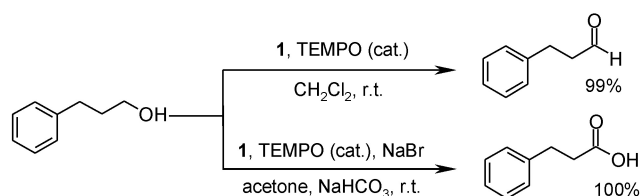
(B) Primary alcohols are oxidized to acids using stoichiometric TCCA and catalytic  $\text{RuCl}_3$  in the presence of *n*- $\text{Bu}_4\text{NBr}$  and  $\text{K}_2\text{CO}_3$  in  $\text{MeCN}/\text{H}_2\text{O}$ . Secondary alcohols are oxidized to ketones in the same set using  $\text{MeCN}/\text{H}_2\text{O}$  or  $\text{EtOAc}/\text{H}_2\text{O}$ . Effects of pH, solvent and base were also studied.<sup>4</sup>

Substrate	Product	Yield (%)
octanol	octanoic acid	95
2-octanol	2-octanone	98
cyclopentanol	cyclopentanone	90

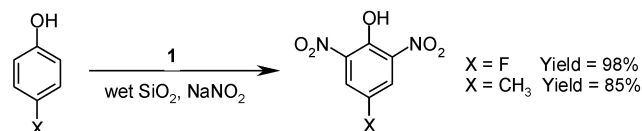
(C) Oxidation of 1,3,5-trisubstituted pyrazolines to the corresponding pyrazoles is achieved using TCCA under both heterogeneous and solvent-free conditions.<sup>5</sup>



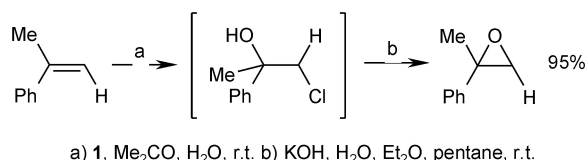
(D) Combination of TCCA and catalytic TEMPO in  $\text{CH}_2\text{Cl}_2$  leads to the conversion of primary alcohols into aldehydes.<sup>6</sup> In the presence of acetone, NaBr and  $\text{NaHCO}_3$ , acids are obtained.<sup>7</sup> Secondary alcohols are oxidized to ketones.



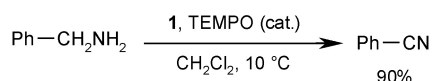
(E) Dinitrophenols are obtained upon reaction of phenols with TCCA,  $\text{NaNO}_2$  and wet  $\text{SiO}_2$  under solid-phase reaction via in situ generation of  $\text{HNO}_2$ .<sup>8</sup>



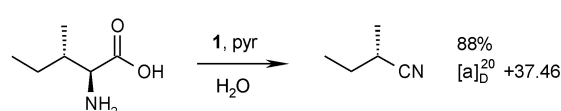
(F) Epoxides can be produced in mild conditions by reaction of alkenes with trichloroisocyanuric acid in aqueous acetone followed by treatment of resulting chlorohydrin with aqueous KOH in  $\text{Et}_2\text{O}$ /pentane.<sup>9</sup>



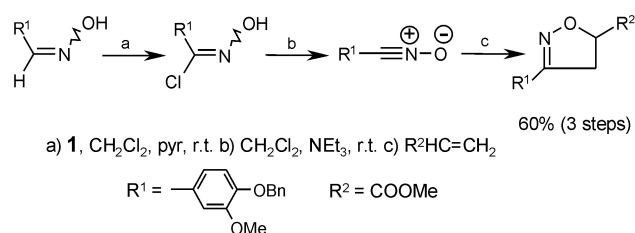
(G) Primary amines are successfully converted into nitriles by means of TCCA and catalytic TEMPO under mild conditions. Other functional groups remain unaffected.<sup>10</sup>



(H) Amino acids are cleanly and efficiently converted into nitriles by means of a decarboxylation reaction carried out with TCCA in water or methanol in the presence of pyridine. Using TCCA, (*S*)-(+)-2-methylbutyronitrile is obtained at the highest optical purity.<sup>11</sup>



(I) Aldoximes derived from an *o*-protected vanillin, when treated with TCCA in the presence of olefins as dipolarophiles, afford nitrile oxides. Subsequent 1,3-dipolar cycloaddition generates the corresponding isoxazolines.<sup>12</sup>



## References

- (1) For a review, see: Tilstam, U.; Weinmann, H. *Org. Process Res. Dev.* **2002**, *6*, 384.
- (2) Chattaway, F. D.; Wadmore, J. *J. Chem. Soc.* **1902**, *81*, 191.
- (3) De Luca, L.; Giacomelli, G.; Nieddu, G. *Synlett* **2005**, 223.
- (4) Yamaoka, H.; Moriya, N.; Ikunaka, M. *Org. Process Res. Dev.* **2004**, *8*, 931.
- (5) Zolfigol, M. A.; Azarifar, D.; Maleki, B. *Tetrahedron Lett.* **2004**, *45*, 2181.
- (6) De Luca, L.; Giacomelli, G.; Nieddu, G. *Org. Lett.* **2001**, *3*, 3041.
- (7) De Luca, L.; Giacomelli, G.; Nieddu, G. *J. Org. Chem.* **2003**, *68*, 4999.
- (8) Zolfigol, M. A.; Madrakian, E.; Ghaemi, E. *Synlett* **2003**, 2222.
- (9) Wengert, M.; Sanseverino, A. M.; Mattos, M. C. S. *J. Braz. Chem. Soc.* **2002**, *13*, 700.
- (10) Chen, F.-E.; Kuang, Y.-Y.; Daí, H.-F.; Lu, L.; Huo, M. *Synthesis* **2003**, 2629.
- (11) Hiegel, G. A.; Lewis, J. C.; Bae, J. W. *Synth. Commun.* **2004**, *34*, 3449.
- (12) Rodrigues, R. C.; Aguiar, A. P. *Synth. Commun.* **2001**, *31*, 3075.