

SYNLETT Spotlight 334

1,3-Dichloroacetone

Compiled by Vittorio Pace



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

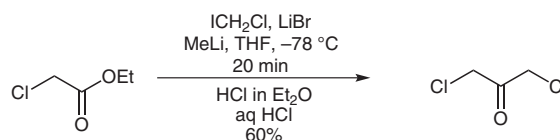
Vittorio Pace was born in Bologna, Italy, in 1981. In 2005, he received his M.Sc. degree in Pharmacy from the University of Perugia under the supervision of Professor M. Curini. Then, he joined the group of Professor J. V. Sinisterra at the Department of Organic and Pharmaceutical Chemistry of the Complutense University of Madrid, where he is currently finishing his Ph.D. thesis under the supervision of Professor Alcántara. He was a visiting Ph.D. student at the Universities of Trieste (Professor Gardossi), Graz (Professor Kroutil), and Ghent (Professor De Kimpe). In 2009, he obtained his M.Sc. degree in Drug Design and Development from the University of Pavia, Italy. His research interest mainly focus on the synthesis and functionalization of α -haloketones.

Department of Organic and Pharmaceutical Chemistry, Faculty of Pharmacy, Complutense University of Madrid, Pza. Ramón y Cajal s/n, 28040 Madrid, Spain
E-mail: vpace@farm.ucm.es

Introduction

1,3-Dichloroacetone (CAS: 534-07-6) is the simplest and most common example of the α,α' -dihaloketone derivatives. It is a crystalline solid (mp 39–41 °C), corrosive, toxic, and has to be handled in a fume hood. It shows a good solubility in organic solvents and a very high high chemical reactivity, justified by the presence of three vicinal electrophilic carbons, which enables it to undergo several chemical transformations. Although it is commercially supplied, it may be prepared by chlorination of aceto-

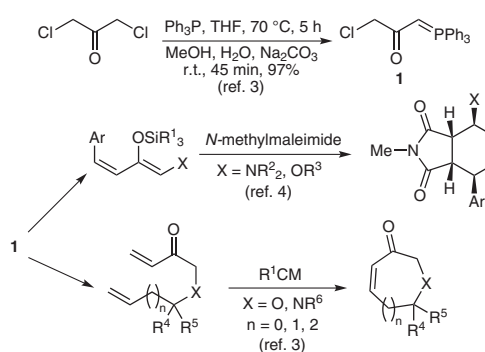
tone in methanol as proposed by Gallucci.¹ Alternatively, an expeditious synthesis has been reported by Barluenga via the in situ formation of a lithium carbenoid, such as chloromethyl lithium, which reacts with the ethyl ester of the chloroacetic acid, as shown in Scheme 1.²



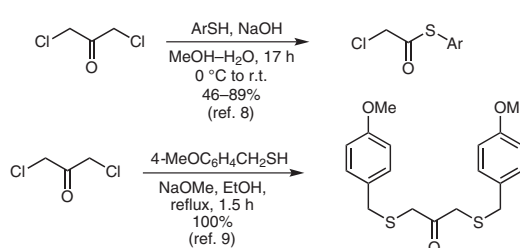
Scheme 1

Abstracts

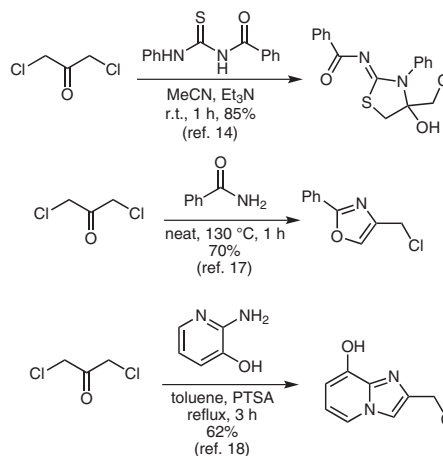
(A) 1,3-Dichloroacetone has been extensively used as substrate to carry out Sn-type reactions with phosphorous nucleophiles (i.e., triphenylphosphine). The obtained ylide **1** represents an useful starting material for further functionalizations³. It is the precursor of syloxy butadienes that may undergo Diels–Alder reactions as reported by Alonso.⁴ Analogously, a second chloro displacement and a Wittig-type reaction on **1** lead to a series of ω -unsaturated α -alkoxy enones and α -amino enones, suitable for ring-closing metathesis reactions.³



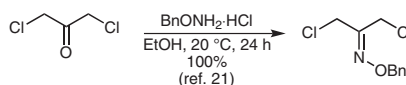
(B) The O -⁵ and S -^{6–8} nucleophiles can perform nucleophilic displacement on 1,3-dichloroacetone, thus representing an useful technique to add a three-carbon unit to organic compounds. By choosing appropriately the stoichiometric ratio between 1,3-dichloroacetone and the nucleophile, it is possible to obtain the substitution of both chlorine atoms.^{9,10}



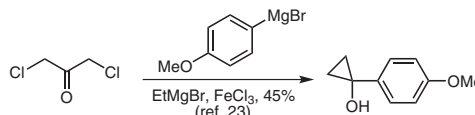
(C) The electrophilic behavior of the vicinal carbon atoms of this reagent is involved in reactions with ambident nucleophiles leading to cyclic systems characterized by the presence of a chloromethyl moiety suitable for further derivatizations.^{11–17} Significantly, the unique examples cited in literature of the use of 1,3-dichloroacetone with aromatic amines entail reactions with highly nucleophilic ambident amines (e.g., 2-aminopyridine).^{18–20}



(D) The activation of the carbonyl moiety by an acid allows the addition to the carbonyl carbon of a suitable nucleophile (hydroxylamine derivatives²¹ or diols).²² It seems that reactions carried out on carbonyl-protected 1,3-dichloroacetone result in better chemoselectivity compared to those conducted on the unprotected one, maybe because of the high acidity of the methylenic protons of the last one.



(E) 1,3-Dichloroacetone is useful as starting material for a one-pot synthesis of several 1-substituted cyclopropanols.^{23,24} In this procedure, the initially formed 2-substituted 1,3-dichloro-isopropoxide is reduced to the desired compounds by using low-valent iron.²⁵ Analogously, cyclopropenone derivatives are readily available from 1,3-dichloroacetone.²²



References

- Gallucci, R. R.; Going, R. *J. Org. Chem.* **1981**, *46*, 2532.
- Barluenga, J.; Llavona, L.; Concellon, J. M.; Yus, M. *J. Chem. Soc., Perkin Trans. 1* **1991**, 297.
- Taillier, C.; Hameury, T.; Bellosta, V.; Cossy, J. *Tetrahedron* **2007**, *63*, 4472.
- Alonso, D.; Caballero, E.; Medarde, M.; Tomé, F. *Tetrahedron Lett.* **2007**, *48*, 907.
- Caselli, E.; Tosi, G.; Forni, A.; Bucciarelli, M.; Prati, F. *Il Farmaco* **2003**, *58*, 1029.
- Bergeot, O.; Corsi, C.; Qacemi, M. E.; Zard, S. Z. *Org. Biomol. Chem.* **2006**, *4*, 278.
- de Greef, M.; Zard, S. Z. *Org. Lett.* **2007**, *9*, 1773.
- Lukowska, E.; Plenkiewicz, J. *Tetrahedron: Asymmetry* **2007**, *18*, 1202.
- Hjelmgaard, T.; Givskov, M.; Nielsen, J. *Org. Biomol. Chem.* **2007**, *5*, 344.
- Li, B.; Lyle, M. P. A.; Chen, G.; Li, J.; Hu, K.; Tang, L.; Alaoui-Jamali, M. A.; Webster, J. *Biorg. Med. Chem.* **2007**, *15*, 4601.
- Bakunova, S. M.; Bakunov, S. A.; Wenzler, T.; Barszcz, T.; Werbovetz, K. A.; Brun, R.; Hall, J. E.; Tidwell, R. R. *J. Med. Chem.* **2007**, *50*, 5807.
- Gaudin, J.-M.; Nikolaenko, O.; de Saint Laumer, J.-Y.; Winter, B.; Blanc, P.-A. *Helv. Chim. Acta* **2007**, *90*, 1245.
- Lilienkampf, A.; Mao, J.; Wan, B.; Wang, Y.; Franzblau, S. G.; Kozikowski, A. P. *J. Med. Chem.* **2009**, *52*, 2109.
- Murru, S.; Singh, C. B.; Kavala, V.; Patel, B. K. *Tetrahedron* **2008**, *64*, 1931.
- Rao, H. S. P.; Vasantham, K. *J. Org. Chem.* **2009**, *74*, 6847.
- Thoma, G.; Streiff, M. B.; Kovarik, J.; Glickman, F.; Wagner, T.; Beerli, C.; Zerwes, H.-G. n. *J. Med. Chem.* **2008**, *51*, 7915.
- Zhao, Q.; Liu, S.; Li, Y.; Wang, Q. *J. Agric. Food. Chem.* **2009**, *57*, 2849.
- Alagille, D.; Koren, A. O.; Kudej, G.; Staley, J.; Cosgrove, K.; Seibyl, J.; Tamagnan, G. D. *J. Label. Comp. Radioph.* **2008**, *51*, 202.
- Henry, N.; Sánchez, I.; Sabatié, A.; Bénétteau, V.; Guillaumet, G.; Pujol, M. D. *Tetrahedron* **2006**, *62*, 2405.
- Szabo, R. m.; Crozet, M. D.; Vanelle, P. *Synthesis* **2008**, 127.
- Goubert, M.; Toupet, L.; Sinibaldi, M.-E.; Canet, I. *Tetrahedron* **2007**, *63*, 8255.
- Isaka, M.; Ejiri, S.; Nakamura, E. *Tetrahedron* **1992**, *48*, 2045.
- Biatti, M.; Capone, A. *J. Org. Chem.* **2008**, *73*, 618.
- DePuy, C. H.; Dappen, G. M.; Eilers, K. L.; Klein, R. A. *J. Org. Chem.* **1964**, *29*, 2813.
- Kochi, J. K.; Singleton, D. M. *J. Org. Chem.* **1968**, *33*, 1027.