Available online at www.sciencedirect.com

Chinese Chemical Letters 20 (2009) 393–396

CHINESE CHEMICAL LETTERS

www.elsevier.com/locate/cclet

A mild, simple and efficient method for selective α-monobromination of 1,3-diketones and β-keto-esters using pyridinium bromochromate

Yaghoub Sarrafi *, Marzieh Sadatshahabi, Kamal Alimohammadi

Department of Chemistry, Mazandaran University, Babolsar, Iran

Received 17 September 2008

Abstract

Pyridinium bromochromate has been found to be a highly efficient and selective reagent for the α-monobromination of 1,3-diketones and β-keto-esters in the absence of base, Lewis acid, or other catalyst. The products were formed in high to excellent yields under mild reaction conditions and in short reaction times.

Keywords: α-Monobromination; β-Keto-esters; Pyridinium bromochromate; 1,3-Diketones

α-Bromination of carbonyl compounds is an important organic transformation as the α-brominated products are useful intermediates in organic synthesis [1]. The monobromination of α-unsubstituted dicarbonyl compounds is difficult as the dibrominated products are also formed [2]. The transformation is usually carried out by using either molecular bromine [3] or Br_2/NaH [4]. However, recently other methods have also been reported employing sodium hypobromite [5], photochemical α-bromination using N-bromosuccinimide [6], V_2O_5–H_2O_2/NH_4Br [7], N,N-dibromobenzenesulfonamide [8], bromodimethylsulfonium bromide (BDMS) [9], NBS [10] and NBS in combination with silica-supported $NaHSO_4$ [11], sulfonic acid functionalized silica [12], Amberlist-15 [13] or in ionic liquids [14]. Though all these methods provide good yields, but most of them involve strongly acidic or basic conditions and or the undesirable formation of α,α-dibrominated products in significant amounts. From the view point of green chemistry [15], the use of molecular bromine has several drawbacks: the reagent itself is harmful and hazardous and there are difficulties in handling and maintaining the stoichiometric ratio during the reaction. In addition, the reaction needs to be carried out under a dry and inert atmosphere and also uses expensive and strong base NaH [4]. Moreover, NBS has also some limitations such as the requirement for dry [16], harsh reaction conditions [11], and NBS and the required solvents such as ionic liquids are expensive [14]. Therefore, there is scope to find an alternative methodology that would be efficient.

---

* Corresponding author.
E-mail address: ysarrafi@umz.ac.ir (Y. Sarrafi).

doi:10.1016/j.cclet.2008.11.022

1. Experimental

1.1. Typical procedure for bromination

To a solution of the dicarbonyl compound (1 mmol) in CH_2Cl_2 (5 mL), PBC (1 mmol) was added and the mixture was stirred at room temperature for the specified period of time (see Table 2). After the reaction was completed (TLC and when a green colour appeared in the reaction mixture), the reaction mixture was filtered and washed with water (2 × 10 mL). The combined organic extracts were dried ($MgSO_4$) and concentrated under reduced pressure. The resulting crude material was either recrystallized from EtOH/H_2O or subjected to column chromatography on silica gel (hexane/ethyl acetate, 10:1) to afford the corresponding pure product. The spectral data of some representative compounds are given below:

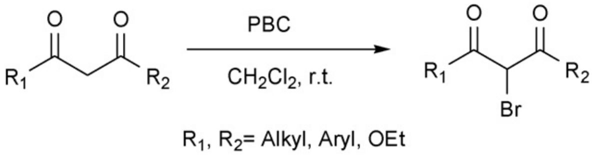
Compound (**1**): IR (KBr) ν 1694, 1679 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$, δ ppm): 6.51 (s, 1H), 7.45 (t, 4H, $J = 7.6$ Hz), 7.58 (t, 2H, $J = 7.6$ Hz), 7.96 (d, 4H, $J = 7.2$ Hz). Compound (**3**): IR (KBr) ν 1633, 1583, cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$, δ ppm): 1.09 (s, 6H), 2.45 (s, 4H), 6.65 (s, 1H). Compound (**8**): IR (Neat) ν 1735, 1716 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$, δ ppm): 1.23 (t, 3H, $J = 7.5$ Hz), 4.20 (q, 2H, $J = 7.5$ Hz), 4.75 (s, 1H).

2. Results and discussion

Recently, we have reported several chromium (VI) complexes for oxidative transformations under nonaqueous and or solvent-free conditions [17]. Based on knowledge of the reactivity of chromium (VI) complexes for bromination [18], we have now developed an acceptable protocol for α-bromination of dicarbonyl compounds using pyridinium bromochromate. Pyridinium bromochromate was easily prepared by the reaction of equimolar quantities of chromium trioxide, 47% aqueous hydrobromic acid and pyridine [19]. It has been used as oxidant and bromination of hydroxy aromatics [18a,19]. In this work pyridinium bromochromate efficiently brominated β-dicarbonyl compounds giving a high to excellent yield of the corresponding monobrominated compounds (Scheme 1).

In order to find optimal conditions, 1,3-diphenyl-1,3-propanedione was chosen as a model substrate. 1,3-Diphenyl-1,3-propanedione was treated with **1** equiv. PBC at room temperature in different solvents such as CH_2Cl_2, THF, CH_3CN, Et_2O and glacial acetic acid. Completion of the reaction was checked by TLC and the colour of the reaction mixture (green) acts as an indicator monitoring the progress of the reaction. The results were shown in Table 1.

Under these reaction conditions, increasing the mole ratio of PBC to 1,3-dicarbonyl compound did not change the yield of the monobrominated product and formation of α,α-dibrominated product was not observed. However, when we treated a 2:1 mole ratio of PBC to 1,3-dicarbonyl compound in CH_2Cl_2 at reflux, the α,α-dibrominated product was obtained. In order to show the generality of this method we have treated PBC with varieties of β-dicarbonyl compounds and the results are presented in Table 2.



Scheme 1. α-Monobromination of 1,3-diketones and β-keto-esters using pyridinium bromochromate.

Table 1
α-Monobromination of 1,3-diphenyl-1,3-propanedione by pyridinium bromochromate in different solvents.

Entry	Substrate	Time (min)	Yield[a] (%)
1	CH_3CN	15	90
2	CH_2Cl_2	15	95
3	THF	25	87
4	Et_2O	90	50
5	CH_3COOH	65	68

[a] Isolated yields.