



## Addition of cyanide to aldehyde and ketons with hetropoly acid praysler

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### Abstract

We wish to report a novel and convenient one pot preparation of various cyanohydrin from carbonyl compounds with trimethylsilyl cyanide as a safer cyanating agent and readily available acid anhydride under the influence of a amount of praysler acid as a mild and efficient catalyst. By this method, aromatic and aliphatic aldehydes and ketones are converted into their corresponding cyanotrimethylsilyl ethers in excellent yields (85– 95%) in short reaction times (<30 min).

*Keywords: Cyanid, Hetropoly acid, Praysler, Catalyst, Carbonyl compound.*

### Introduction

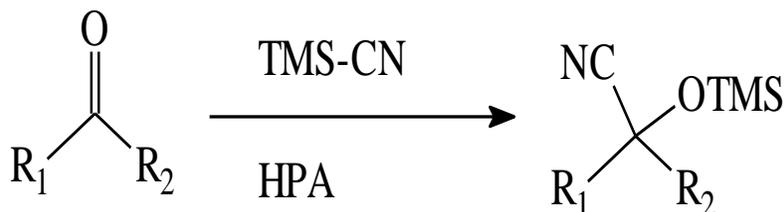
The cyanation reaction of carbonyl compounds is one of the most powerful procedures for the synthesis of poly-functional molecules [1]. Cyanohydrins or cyanohydrins trimethylsilyl ethers can easily be converted to ahydroxycarboxylic acids [2],  $\alpha$ -hydroxyaldehydes [3],  $\beta$ -aminoalcoholes [4],  $\alpha$ -amino acid derivatives [5]. In addition, they also have been used for the synthesis of insecticides [6], ferroelectrics, and liquid crystals [7,8]. Several useful cyanating reagents have been reported in the literature [9]. Among various cyanating agents such as potassium or sodium cyanide and HCN, the use of trimethylsilyl cyanide is safe and a more effective cyanide anion source for nucleophilic addition to carbonyl compounds under mild conditions[10] Generally TMS-CN reacts with a carbonyl compound in the presence of a catalyst. Many different catalysts have been developed for this reaction [9]. Lewis acids and some other additives, both in stoichiometric and catalytic amounts have been used as promoting agents for cyanating of carbonyl compounds [11]. In recent years, several optically active catalysts for asymmetric synthesis of cyanohydrins have also been reported in the literature [12].

Recently, lanthanide triflates were also reported to be efficient catalysts in promoting cyanation reactions of carbonyl compounds [13]. However, only few methods have been reported for the cyanation of substituted and functionalized ketones [14]. Furthermore, many of these methods involve the use of expensive reagents, strongly acidic conditions and extended reaction times. In addition, some of these methods are limited to simple aliphatic ketones and are not applicable to aryl or sterically hindered ketones. Thus, there is still a need to develop a simple, convenient and efficient method for the cyanation of both aliphatic and aromatic ketones using inexpensive and readily available reagents.

Polyoxometalates have proved to be good catalysts for various oxidations. They are applied in bulk or supported forms, and both homogeneous and heterogeneous catalyses are possible. Due to their acidic and redox properties, heteropoly compounds

(heteropoly acids and salts) are useful and versatile catalysts in a number of transformations. Since they exhibit weak superacidic properties, they can be used in reactions requiring electrophilic catalysis [15]. Having these factors in mind, we now wish to report that preyssler acid ( $H_{14}NaP_5W_{30}O_{110}$ ) is an excellent and effective catalyst for preparation of various cyanohydrin from carbonyl compounds with trimethylsilyl cyanide at room temperature.

The substrate scope of this method was investigated under standard reaction conditions, and the results are shown in Table 1.



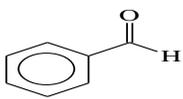
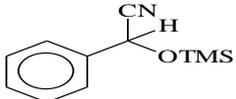
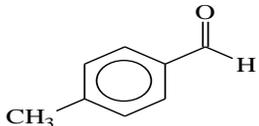
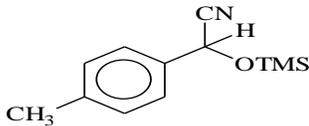
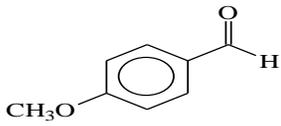
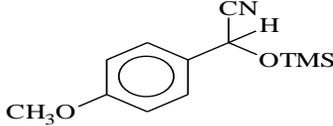
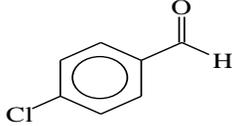
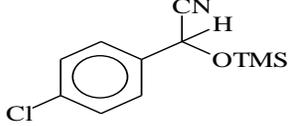
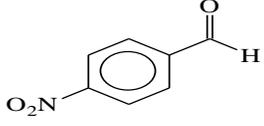
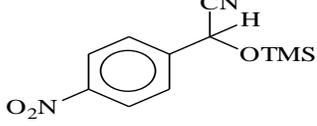
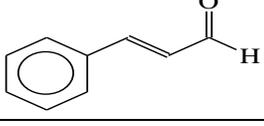
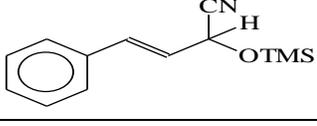
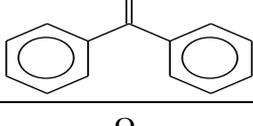
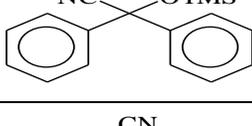
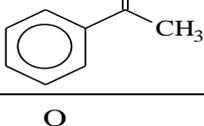
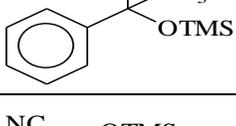
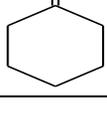
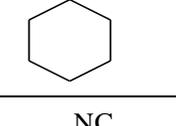
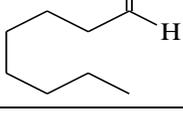
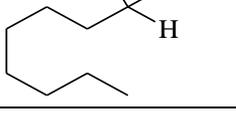
Benzaldehyde was chosen to optimize the reaction conditions, such as temperature, time, and molar ratio of solid preyssler acid to substrate. The reaction with both aldehydes and ketones afforded the corresponding cyanohydrins in excellent yields. The reaction was conducted under the optimal conditions with various aromatic and aliphatic aldehydes and ketones. The successful results are summarized in Table 2. In the case of benzaldehyde having an electron-donating group such as tolualdehydes, the corresponding cyanohydrin could be obtained in good to high yields (entries 2-3). As regards benzaldehyde having an electron-withdrawing group, the corresponding hydrine was also obtained in good to excellent yields (entries 4-5).

Furthermore, we have found that this reaction is similarly effective for aromatic, aliphatic, and alicyclic ketones (entries 7-9) to yield the corresponding cyanohydrins in good to high yields. Similarly, aliphatic aldehydes, octanal afforded cyanohydrins in high yields (entire 10).

In summary, the paper describes a simple and efficient method for the cyanation of various functionalized and hindered ketones with TMS-CN using the cheap and readily available hetopoly acid as the catalyst. This method is effective for the cyanation of both aliphatic as well as aromatic ketones. In addition to its efficiency, operational simplicity and mild reaction conditions, this method provides high yields of products within a short time, which makes it a useful entry for the synthesis of trimethylsilyl ethers of cyanohydrins.

## General

Chemicals were purchased from Merck and Fluka Chemical Companies. Preyssler acid ( $H_{14}NaP_5W_{30}O_{110}$ ) was prepared according to the reported procedures [16]. All the products are known and were characterized by comparison of their physical data with those reported in the literature. IR spectra were run on a Shimadzu model 8300 FT-IR spectrophotometer. NMR spectra were recorded on a Bruker DPX-100. The purity of the products and the progress of the reactions were accomplished by TLC on silica-gel poly gram SILG/UV254 plates or by a Shimadzu Gas Chromatograph GC-14A instrument with a flame ionization detector.

Entry	Substrate	Product	Time (min)	Yield%
1			10	95
2			10	95
3			8	95
4			15	90
5			30	88
6			15	90
7			15	95
8			15	85
9			30	85
10			30	85

**Table 1:** preparation of various cyanohydrin from carbonyl compounds with trimethylsilyl cyanide at room temperature.

### General procedure

A mixture of a carbonyl compound (2 mmol), heteropoly acid praysler (0.01% mmol) and TMSCN (2.4 mmol) in  $\text{CH}_2\text{Cl}_2$  (5 ml) was stirred at room temperature (r.t.). After complete conversion as indicated by TLC, the reaction mixture was quenched

with water (15 mL) and extracted with dichloromethane (2×15 mL). The combined extracts were washed with 15% solution of sodium thiosulphate, dried over anhydrous Na<sub>2</sub>SO<sub>4</sub>, and concentrated in vacuum. The resulting product was purified by column chromatography on silica gel (Merck, 100–200 mesh, ethyl acetate hexane, 1:9) to afford the pure trimethylsilyl derivative of the cyanohydrin.

## Acknowledgements

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## Reference

1. R.H.J.Geregory; *Chem.Rev.*, 99, 3649 (1999); (b) R.O.Dulaler, A.Hafner; *Chem.Rev.*, 92, 807 (1992); (C) I.Oyima (Ed.), *Catalytic asymmetric synthesis*, VCH, New York, (1993); (d) D.A.Evans, G.L.Carrol, C.K.Truesdale; *J.Org.Chem.*, 39, 914 (1974).
2. B.R.Mathews, H.Gountzos, W.R.Jackeon, K.G.Walson; *Tetrahedron Lett.*, 30, 5157 (1989); (b) T.Ziegler, B.Horsch, F.Effenberger; *Synthesis*, 575 (1990).
3. W.R.Jackson, H.A.Jacobs, G.S.Jayalilake, B.R.Mathews, K.G.Walson; *Aust.J.Chem.*, 43, 2045 (1990).
4. F.Effenberger, B.Gutterer, B.J.Jager.; *Tetrahedron: Asymmetry*, 8, 459 (1997), (b) F.Effenberger, B.Gutterer, B.J.Jager., *J.Org.Chem.*, 62, 3867 (1997).
5. P.Zandbergan, J.Brussee, G.A.Vander, G.G.Kruse; *Tetrahedron: Asymmetry*, 3, 769 (1992); (b) C.R.A.Goldfrey (Ed.), *Agrochemicals from Natural Products*, Marcel Dekker, New York, (1995).
6. T.Kusumoto, T.Hanamoto, S.Hiyama, T.Takehera, M.Shoji, T.Osawa, K.Kuriyama, T.Nakamura, Fujisawa; *Chem.Lett.*, 1615 (1990).
7. M.Bandini, P.G.Cozzi, P.Melchiorre, A.Umani-Ronchi; *Tetrahedron Lett.*, 42, 3041 (2001).
8. D.A.Evans, K.Truesdale; *Tetrahedron Lett.*, 49, 4929 (1973).
9. Z.Wang, B.Fetterty, J.G.Verkaide; *J.Organometallic Chem.*, 646, 161 (2002). (a) W.C.Groutas, D.Felker; *Synthesis*, 861 (1980); (b) A.Fujii, S.Sakaguchi, Y.Ishii; *J.Org.Chem.*, 65, 6209 (2000).
10. S.Liang, X.R.Bu; *J.Org.Chem.*, 67, 2702 (2002); (b) L.Z.Floves Lopez, M.Parra-Hake, R.Somanathanand P.J.Walsh; *Organometallics*, 19, 2153 (2000).
11. M.Curini, F.Epifanio, M.C.Marcotullio, O.Rasali, M.Rossi; *Synlett*, 315 (1999); (b) D.E.Ward, M.Hrapchak, M.Sales; *Org.Lett.*, 2, 57 (2000).
12. Y.Yang, D.Wang; *Synlett*, 861 (1997); (b) Y.Yang, D.Wang; *Synlett*, 1379 (1997).
13. M.Bandini, P.G.Cozzi, P.Melchiorre, A.Umani-Ronchi, *Tetrahedron Lett.*, 42, 3041 (2001); (b) M.Golinski, C.P.Brock, 14. D.S.Watt; *J.Org.Chem.*, 58, 159 (1993); (C) Y.Hamashima, M.Kanai, M.Shibasaki; *J.Am.Chem.Soc.*, 122, 7412 (2000).
15. H.Firouzabadi, N.Iranpoor, K.Amani; *Green Chem.*, 3, 131 (2001); (b) H.Firouzabadi, N.Iranpoor, K.Amani; *Synthesis*, 59 (2002); (C) H.Firouzabadi, N.Iranpoor, K.Amani; *Synthesis*, 408 (2003).
16. C.Preyssler; *Bull.Soc.Chem.Fr*, 30 (1970); (b) M.H.Alizadeh, S.P.Harmalker, Y.Jeanin and M.T.Pope; *J.Am.Chem.Soc.*, 107, 2662 (1985); (C) M.H.Alizadeh, H.Razavi, F.Farrash Bamoharram, M.K.Hassanzadeh, R.Khoshnavazi, F.Mohammadizonoz; *Kinetics & Catalysis*, 44, 524 (2003).