

SELECTIVE TRICHLOROMETHYLATION OF DIALKYLARENES AT β -POSITION OF THE RING PROMOTED BY ARENE π -COMPLEXATION WITH THE IRON(Cp) MOIETY

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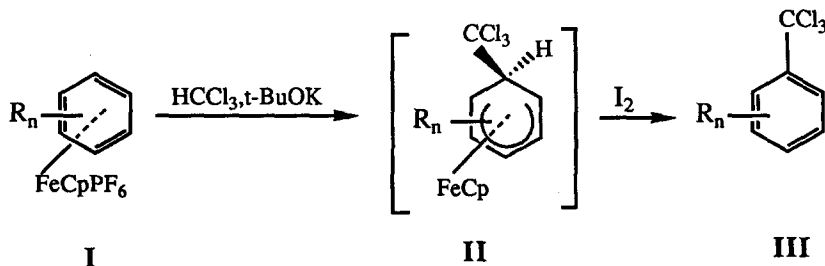
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ABSTRACT : Dialkyltrichloromethylarenes with CCl_3 group located at β -position to alkyl substituents of indan, tetralin, benzosuberane and isomeric xylenes are synthesized selectively in the reaction promoted by π -complexation of arene with cyclopentadienyliron moiety.

High reactivity of trichloromethylarenes allows for their easy conversion into acids and their derivatives¹⁻⁴ or for their direct use in organic synthesis as acid equivalents as has been demonstrated recently in the synthesis of heterocyclic compounds.^{2,5,6} They may be also converted efficiently into trifluoromethylarenes which are of significant importance in the synthesis of agrochemical and pharmacological agents.^{1,7} In recent years significant research efforts have been directed toward the search for simple but efficient and selective methods of introduction of trichloromethyl group to arenes. Classical methods of radical chlorination or electrophilic trichloromethylation of alkylarenes are of restricted value because competitive or subsequent reactions contribute significantly to their final outcome. In recent developments the more selective dichlorine monoxide has been utilized in the chlorination process.¹ Interesting results have also been reported for the chlorination of benzylsulfide with chlorine⁴ and a chlorination of benzyl or benzal chlorides with alkylperhalides under phase-transfer conditions.³ Electrophilic trichloromethylation of polyalkylbenzenes has been reexamined² and a mass-spectrometric study of the gas-phase reaction of the trichloromethyl cation with arenes presented.⁸ Each of these methods suffers from drawbacks since they require pre-preparation of starting materials, lead to mixtures of products and their application may be limited to certain arenes. As a result, the search for methods allowing for a selective introduction of trichloromethyl group to alkylarenes still constitutes a synthetic challenge. In this communication we wish to report on the first example of such a reaction promoted by a complexation of an arene with a cyclopentadienyliron moiety.

The Scheme outlines a one-pot reaction sequence. Pre-generated trichloromethyl anion reacts with the cyclopentadienyliron complexed arene **I** forming an intermediate adduct **II** which is subsequently demetallated *in situ* giving the trichloromethylarene **III** in a good yield. The trichloromethyl anion is generated by treatment of chloroform

with potassium t-butoxide at low temperature⁹ while demetallation concluding the sequence is achieved upon treatment with iodine. Overall, the proposed procedure is simple, involves readily available starting materials¹⁰ and leads to products free of contamination by products of competitive reactions. The procedure has not been completely optimized and therefore the yields may be improved.


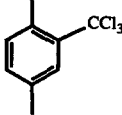

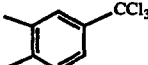

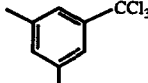
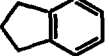
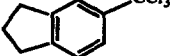
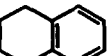
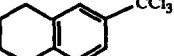
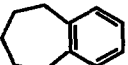
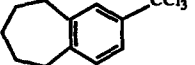


Scheme

In general terms the procedure follows the pathway of arene functionalization in an addition-demetalation sequence. This method has been extensively studied and many interesting, sometimes highly selective reactions have been described.¹¹ Most of the attention has been focussed on the reactions of tricarbonyl chromium¹² and cyclopentadienyliron complexes¹³ with various nucleophiles. It should be stressed however that direct trichloromethylation in the reaction of trichloromethyl anion with an organometallic complex has not yet been reported. Our results indicate that the regioselectivity of the first step, i.e. addition to the metal complex, leading to the formation of a single β -isomer is thermodynamically controlled.¹⁴ A similar conclusion has been drawn from studies on addition of the alkylnitrile anions to naphthalene or quinoline chromium tricarbonyls.¹⁵ We are currently studying reactions of this anion with other cyclopentadienyliron complexes of mono- and disubstituted arenes in an attempt to establish the scope of this reaction and a range of its possible synthetic applications.

In a typical experimental procedure, 2 mmol of **I** was introduced to a solution prepared by stirring 896 mg (8 mmol) of t-BuOK and 5 ml of CHCl_3 in 20 ml of THF at -78°C . The mixture was allowed to warm up to room temperature and the stirring was continued over a period of time (See Table) at room temperature. A solution of 40 mg of I_2 in 10 ml of THF was then introduced and the mixture was stirred for another 10-12 h. The resulting mixture was diluted with ether and solid material was removed by filtration. The ethereal solution gives a crude oily product after a routine work-up. Pure trichloromethylarenes were isolated via microdistillation.^{16,17}

Table. Trichloromethylation of some dialkylarenes.

Entry	Arenes in I	Addition time	Products IIIa-III f	Yield (%) of III
a		1 h		53 ¹⁸
b		4 h		55 ¹⁸
c		4 h		50
d		24 h		45
e		1 h		65
f		1 h		52

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14. For indan we found the following distribution of isomeric intermediates **II** in various reaction times:
a : b, 50 : 50 (1h), 40 : 60 (4h), 15 : 85 (18h).
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16. Satisfactory elemental analyses have been obtained for **IIIa-IIIf** and intensities of isotopic peaks for M^+ , $[\text{M}+2]^+$ and $[\text{M}+4]^+$ in MS are in agreement with presence of three chlorine atoms.
- ^1H and ^{13}C NMR data (CDCl_3 , ppm from TMS) for **IIIa-IIIf**: **IIIa**; δ 7.87 (s,1H), 7.18-7.1 (m,2H), 2.72 (s,3H), 2.37 (s,3H); δ 140.42, 135.13, 133.38, 133.32, 131.06, 126.49, 98.15 (CCl_3), 27.54, 21.05. **IIIb**; δ 7.68 (s,1H), 7.64 (d,8.1Hz,1H), 7.17 (d,8.0Hz,1H), 2.32 (s,3H), 2.29 (s,3H). δ 141.81, 139.32, 136.71, 129.38, 126.55, 122.78, 97.79 (CCl_3), 19.91, 19.47. **IIIc**; δ 7.53 (s,2H), 7.03 (s,1H), 2.36 (s,6H); δ 144.02, 138.01, 131.85, 123.18, 97.85 (CCl_3), 21.28. **III d**; δ 7.77 (s,1H), 7.70 (d,8.1Hz,1H), 7.24 (d,8.0Hz,1H), 2.98-2.90 (m,4H), 2.15-2.10 (m,2H); δ 147.01, 144.65, 142.44, 123.94, 123.69, 121.47, 98.15 (CCl_3), 32.75, 32.56, 25.50. **IIIe**; δ 7.64-7.61 (m,2H), 7.12 (d,8.8Hz,1H), 2.82-2.79 (m,4H), 1.84-1.80 (m,4H); δ 141.44, 139.86, 137.14, 129.05, 125.96, 122.56, 97.88 (CCl_3), 29.47, 29.09, 22.90, 22.83. **III f**; δ 7.64-7.60 (m,2H), 7.13 (d,7.7Hz,1H), 2.86-2.80 (m,4H), 1.85-1.83 (m,2H), 1.68-1.62 (m,4H); δ 146.12, 143.62, 141.79, 128.85, 126.03, 122.94, 97.84 (CCl_3), 36.75, 36.23, 32.52, 28.00, 27.87.
17. In the chromatographic purification of compounds **IIIa** and **IIIb**, corresponding carboxylic acids are isolated instead of **IIIa** and **IIIb**.
18. Ref.2: compound **IIIb** has not been characterized.

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