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Simple Ion Exchange Procedure of Common Anions to TRISPHAT. Application to the Purification of Cationic Species.

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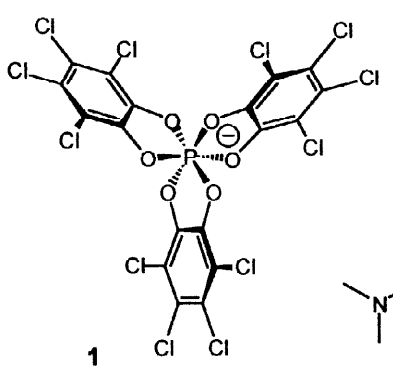
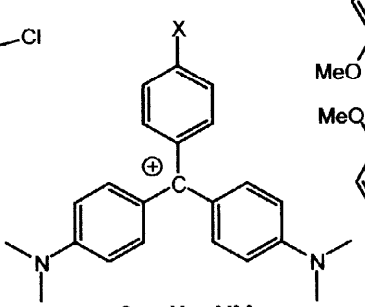
Abstract: Triarylcarbenium, monomethine cations are poorly retained on polar chromatographic phases when associated with TRISPHAT as counterion as opposed to classical anions. This allows an easy separation and purification of these organic cationic salts.

Ion pairing is an essential feature in chemistry.[1] The nature of the anion associated with a cation can dramatically accelerate a reaction, improve its selectivity or even change its course.[2] In this context, we have been interested in synthesising anions that would confer unique properties to the resulting ion pairs (IP), and more particularly, chiral anions that would be used for asymmetric purposes with prochiral or chiral cations.

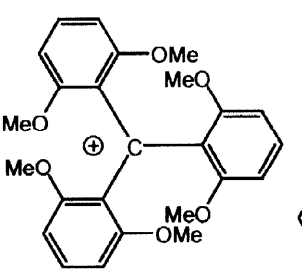
Recently, we have shown that the easily prepared and resolved chiral tris(tetrachlorobenzenediolato)phosphate anion **1** (or TRISPHAT) is configurationally stable as an ammonium salt.[3] Most applications of TRISPHAT as a chiral reagent[4] require the direct association of **1** with a prochiral or chiral target cation. Herein, we report a fast and simple procedure for the ion exchange of common anions to TRISPHAT: Ion pairs of some triarylcarbenium, monomethine cations and **1** are poorly retained on polar chromatographic phases. This allows their isolation by simple chromatography, as well as, in some instances, the purification of the cationic partner.



1 TRISPHAT



2 X = NMe_2
3 X = H



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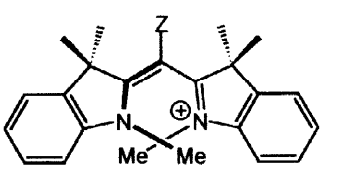

5 Z = H
6 Z = Cl
7 Z = Br

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The aromatic nature of the tetrachlorocatechol ligands around the central phosphorus atom encouraged us to examine whether TRISPHAT would associate itself preferentially with cations containing also aromatic residues. The resulting salts would have a definite lipophilic character and might behave as "non polar" compounds on a polar chromatographic phase. In such a case, to associate the desired organic cation with TRISPHAT, and possibly purify it simultaneously, it would be sufficient to dissolve two precursor salts together and isolate the preferred IP by simple chromatography. We decided to test this hypothesis with commercially available or easily prepared stable triarylcarbenium cations (**2-4**) and cationic monomethine dyes (**5-7**).[5,6]

Solutions of equimolar amounts of tri-*n*-butylammonium TRISPHAT (**1a**, [Bu_3NH^+, (±)-**1**]) and salts [**2-7**, $\mathbf{X}^-$]^7 in CH_2Cl_2 were prepared. Purification of these mixtures by chromatography over SiO_2 or Al_2O_3 afforded as the major products, the desired IP [**2-7**, **1**] in good to excellent yields (Table 1, 65-95%).

Table 1

Entry	Precursor Salt	Phase	Yield [%]
1	[**2**, Cl^-]	SiO_2	84
2	[**2**, Cl^-]	Al_2O_3	91
3	[**3**, oxalate]	SiO_2	72
4	[**4**, BF_4^-]	SiO_2	79
5	[**4**, $CF_3CO_2^-$]	SiO_2	85
6	[**5**, BF_4^-]	SiO_2	64
7	[**6**, BF_4^-]	SiO_2	95
8	[**7**, BF_4^-]	SiO_2	88

As foreseen, we observed that IP [**2-7**, **1**] exhibited much reduced affinity for polar adsorbent surfaces and were retained to a much lower extent. Chromatography over polar adsorbents (SiO_2 or Al_2O_3, CH_2Cl_2 as eluent) of the equimolar mixtures of **1a** and [**2-7**, $\mathbf{X}^-$] salts afforded, as the most eluted compounds, the [**2-7**, **1**] derivatives. Silica gel was usually preferred to alumina as chromatographic phase as leading to less streaking of the derivatives. However, slightly lower yields were obtained (Table 1, entries 1 and 2). The nature of the anionic counterion in the precursor salt seems to have some but little influence on the anion exchange (entries 4 and 5). The behaviour of the [**2-7**, **1**] ion pairs is quite remarkable as the precursor salts [**2-7**, $\mathbf{X}^-$] do not migrate at all under those chromatographic conditions (Table 2).

The retention of salts [**2-7**, **1**] on silica gel depended upon the nature of the cation and the concentration of the salt (Table 2). At higher concentrations, salts [**2-7**, **1**] streaked on TLC. We have, therefore, not calculated retardation factors (R_f), but rather measured the distance moved by the analyte band to the *top* (and not to the center) of the spot: The derived ratios, called just R, for the resulting IP were in the range of 0.75 to 0.85 at 10^{-2} *M* and 0.25-0.35 at lower concentration

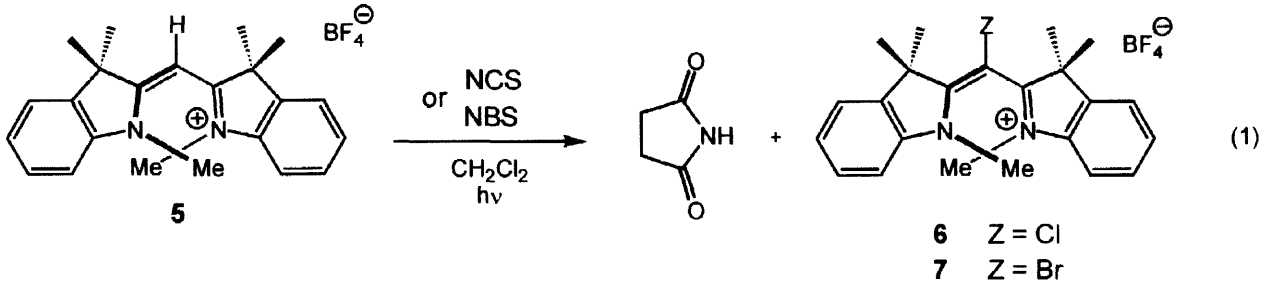
(10^{-4} *M*). Triarylcarbenium cations (Table 2, entries 1-3) were slightly less retained on SiO_2 than monomethine dyes (entries 4-6).

Table 2

Entry	R [2-7, X^-] [b, e]	Salts	R [a, b]	R [a, c]	R [a, d]
1	< 0.05	[2, 1]	0.85	0.62	0.35
2	< 0.05	[3, 1]	0.85	0.64	0.36
3	< 0.05	[4, 1]	0.80	0.60	0.36
4	< 0.05	[5, 1]	0.80	0.54	0.29
5	< 0.05	[6, 1]	0.75	0.49	0.26
6	< 0.05	[7, 1]	0.78	0.51	0.26

[a] R represents the distance moved by the analyte band to the top of the spot;
[b] 10^{-2} *M* solution; [c] 10^{-3} *M* solution; [d] 10^{-4} *M* solution;
[e] Precursor salts: see Table 1.
All solutions prepared in CH_2Cl_2.

This anion exchange procedure can be used to purify cations that are otherwise difficult to isolate pure from their crude reaction mixtures. Salts [**6**, BF_4^-] and [**7**, BF_4^-], prepared by treatment of [**5**, BF_4^-] with NCS and NBS respectively (eq 1), cannot be easily purified using classical techniques: the by-product succinimide has a similar solubility as the salts [**6-7**, BF_4^-] in most solvents, prohibiting the isolation in high yield of the desired ion pairs by recrystallization; salts [**6-7**, BF_4^-] decompose upon flash chromatography over SiO_2 (eluents CH_2Cl_2 and CH_2Cl_2 : MeOH, 9:1) to give fractions containing **5** and **6-7** salts altogether. This anion exchange procedure allowed the clean isolation of the halogenated cations as the corresponding [**6-7**, **1**] salts in good yields (Table 1, entries 7 and 8). The use of CH_2Cl_2 as the only solvent as well as the fast elution of [**6-7**, **1**] on the chromatographic phase are probably responsible for the clean purification without degradation of the cations.



(1)

In summary, the chiral anion **1** is a useful counterion for the purification of cations by simple chromatography. We have observed that the resulting IP can be poorly retained on polar chromatographic phases. We think that this technique will be quite general for organic cationic species of similar shape and geometry to **2-7**.[8] Further studies are conducted to

determine if this procedure can be used for the resolution of configurationally stable chiral cations using enantiopure or enriched TRISPHAT anion and, with configurationally labile derivatives, the extent of asymmetric induction from the anion onto the cations.

Experimental Procedure: In a 25 mL flask, CH_2Cl_2 (4 mL) was added to 57 mg of salt **1a** (60 μmol, 1.0 equiv) and one of precursor salts [**2-7**, X^-] (60 μmol, 1.0 equiv). After complete dissolution of the salts, the resulting solution was stirred for 5 min and then concentrated *in vacuo*. Chromatography over SiO_2 (or Al_2O_3, 1.5 x 15 cm, CH_2Cl_2) and subsequent concentration *in vacuo* afforded as the most eluted compound the title products [**2-7**, **1**] as bright colourful solids. Compounds [**2-7**, **1**] were fully characterised by NMR (^1H, ^{13}C and ^{31}P), IR, UV, MS.

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References and Notes:

1 a) Loupy, A.; Tchoubar, B. *Salt Effects in Organic and Organometallic Chemistry*1st ed.; VCH: Weinheim, 1992; b) Loupy, A.; Tchoubar, B.; Astruc, D. *Chem. Rev.* **1992**, *92*, 1141-1165.

2 a) Evans, D. A.; Murry, J. A.; von Matt, P.; Norcross, R. D.; Miller, S. J. *Angew. Chem., Int. Ed. Engl.* **1995**, *34*, 798-800; b) Chen, Y.-X.; Stern, C. L.; Marks, T. J. *J. Am. Chem. Soc.* **1997**, *119*, 2582 -2583; c) Grieco, P. A.; Clark, J. D.; Jagoe, C. T. *J. Am. Chem. Soc.* **1991**, *113*, 5488-5489.

3 a) Lacour, J.; Ginglinger, C.; Grivet, C.; Bernardinelli, G. *Angew. Chem.* **1997**, *109*, 660-662; *ibid.*, *Angew. Chem., Int. Ed. Engl.*, **1997**, *36*, 608-609.

4 TRISPHAT is an efficient NMR chiral shift reagent for cationic complexes of transition metals: Lacour, J.; Ginglinger, C.; Favarger, F.; Torche-Haldimann, S. *Chem. Commun.* **1997**, in press.

5 For the synthesis of **4**, see: a) Wada, M.; Mishima, H.; Watanabe, T.; Natsume, S.; Konishi, H.; Hayase, S.; Erabi, T. *J. Chem. Soc., Chem. Commun.* **1993**, 1462-1463; b) Wada, M.; Mishima, H.; Watanabe, T.; Natsume, S.; Konishi, H.; Kirishima, K.; Hayase, S.; Erabi, T. *Bull. Chem. Soc. Jpn.* **1995**, *68*, 243-249.

6 For the synthesis of **5-7**, see: a) Grahn, W. *Liebigs Ann. Chem.* **1981**, 107-121; b) Grahn, W.; Johannes, H.-H.; Rheinheimer, J.; Knieriem, B.; Würthwein, E.-U. *Liebigs Ann.* **1995**, 1003-1009.

7 X^- symbolise "traditional" anions, *e.g.* BF_4^-, Cl^-, etc. See Table 1 for their nature in salts [**2-7**, X^-].

8 a) Eggers, L.; Buss, V.; Henkel, G. *Angew. Chem., Int. Ed. Engl.* **1996**, *35*, 870-872; b) Ito, S.; Fujita, M.; Morita, N.; Asao, T. *Chem. Lett.* **1995**, 475-476; c) Ito, S.; Fujita, M.; Morita, N.; Asao, T. *Bull. Chem. Soc. Jpn.* **1995**, *68*, 3611-3620.