REACTION OF 2-BENZOSELENOPYRYLIUM SALTS WITH NUCLEOPHILES: FORMATION OF 1-FUNCTIONALIZED ISOSELENOCHROMENES[1]

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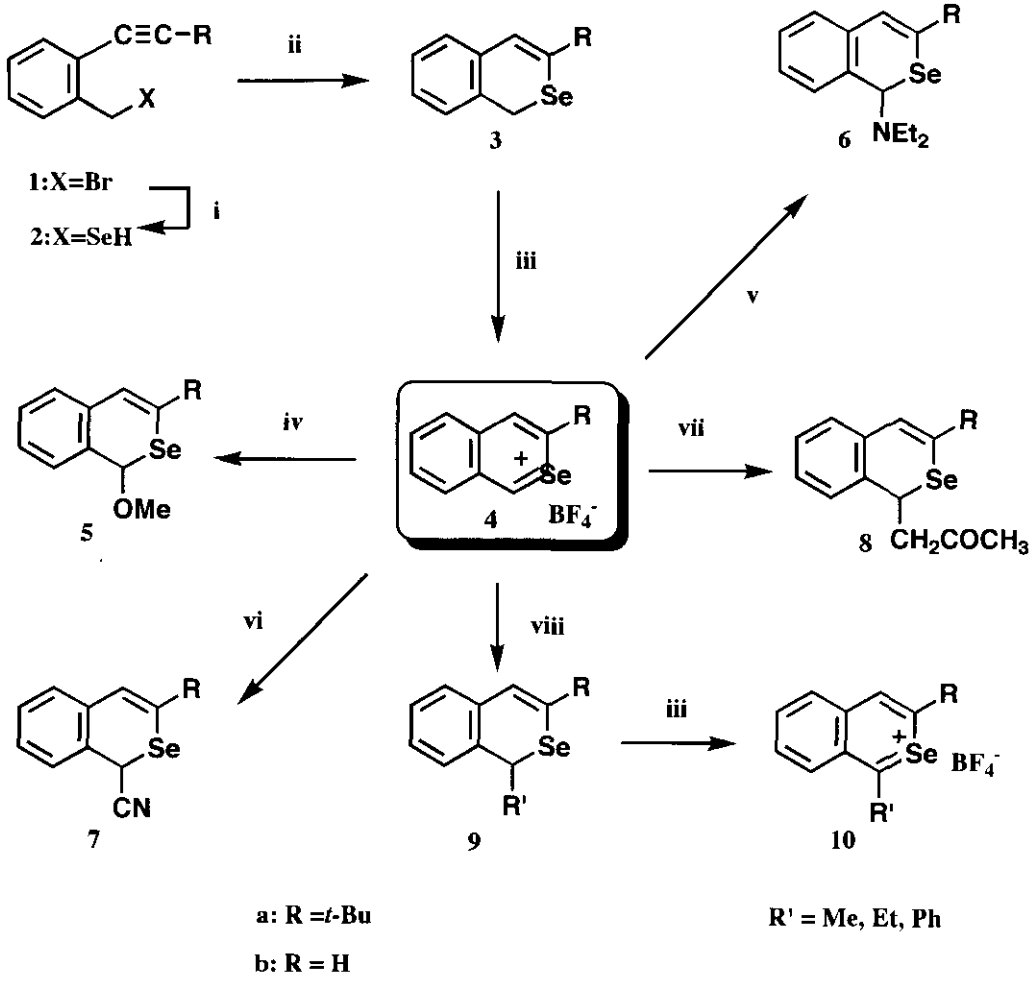
Abstract - 1-Unsubstituted isoselenochromenes (**3**) were converted into the 2-benzoselenopyrylium salts (**4**) by treatment with $Ph_3C^+ BF_4^-$ and the reaction of the salts (**4**) with several nucleophilic reagents (alcohol, amine, cyanide, acetone, and Grignard reagents) afforded the corresponding 1-functionalized isoselenochromenes (**5-9**) in high yields, respectively. 1-Alkyl- and 1-phenyl-2-benzoselenopyrylium salts (**10**) were also obtained from **9**.

The chemistry of the thiopyrylium salts[2] has received increasingly intensive study and their reactivities have been extensively investigated. In contrast, the telluro-[3] and the selenopyrylium salts[4,5] have been prepared, however the reactivities of these pyrylium compounds are not yet examined sufficiently. We have previously focused on the synthesis of various tellurium- or selenium-containing heterocycles,[6] and more recently reported the first preparation of the 2-benzotelluropyrylium tetrafluoroborates[7] by the dehydrogenation of the 1-unsubstituted isotellurochromenes, and their reactivity towards Grignard reagents. But the direct preparation of the 1-substituted 2-benzotelluropyrylium salts and their precursors, and the 1-substituted isotellurochromenes have not been achieved, because *o*-ethynylbenzyl bromides (**1**) were used as starting materials for the preparation of them. In our continuing studies on the syntheses and the reactivities of these salts, this communication describes the synthesis of the selenium-analogues, the 2-benzoselenopyrylium salts (**4**) and the high regioselective reactivity at the C-1 position of the title pyrylium

salts with some nucleophiles. Thus, it opens a novel and easy route to introduce a variety of substituents on C-1 position of the isoselenochromene ring.

The 2-benzoselenopyrylium salts (**4**) were synthesized in the similar manner as described for the preparation of the 2-benzotelluropyrylium salts.[7] Treatment of *o*-ethynylbenzyl bromides (**1**) with 1.2 equiv. of sodium hydrogen selenide,[8] which was generated from selenium powder and sodium borohydride, in



Scheme

Regents and Conditions: i, NaHSe, DMF, 0 °C; ii, EtOH, 80-90 °C; iii, $Ph_3C^+BF_4^-$, $MeNO_2$, rt; iv, MeOH, rt; v, Et_2NH, benzene, rt; vi, KCN, 18-crown-6, MeCN, rt; vii, MeCOMe, rt,viii, R'MgX, ether or THF, 0 °C.

DMF at 0 ℃, followed by addition of ethanol, and then heating at 80-90 ℃ for 1-3 h, resulted in a direct ring closure to give the isoselenochromenes (**3**)[9] in good yields (**3a**: 70% yield, **3b**: 59% yield), *via* the presumed benzyl selenol intermediates (**2**). The isochromenes (**3**) were treated with 1.05 equiv. of triphenylcarbenium tetrafluoroborate (Ph_3C^+ BF_4^-) in $MeNO_2$ at room temperature to afford the desired 2-benzoselenopyrylium tetrafluoroborates (**4**)[10] as yellow prisms (**4a**: 90% yield, **4b**: 85% yield). Thus, we have succeeded in the preparation of the isolable 2-benzoselenopyrylium salts (**4**); the salt (**4b**, R=H, counter-ion for the salt is perchlorate) was already synthesized by Renson *et al.*[4] in 1966, however, *tert*-butyl derivative (**4a**) is hitherto unknown compound.

These pyrylium salts (**4**) were, as expected, more reactive towards nucleophilc reagents than thiopyrylium salts, and extremely moisture sensitive to decompose. On dissolution of the salts (**4**) in absolute methanol, **4** readily decomposed to afford the 1-methoxyisoselenochromenes (**5**).[11] This reaction smoothly proceeds under the condition of the presence of a base catalyst such as sodium methoxide, quantitatively (**5a**: 96% yield, **5b**: 93% yield). Secondary (isoprpanol) and tertiary alcohol (*tert*-butanol) reacted less effectively. Moreover, nucleophilic attack of amine (diethylamine in benzene) and a cyanide ion (potassium cyanide in the presence of 18-crown-6 as a phase transfer catalyst in MeCN) to the C-1 position of the pyrylium ring gave 1-diethylamino- (**6**) and 1-cyanoisoselenochromenes (**7**) in good to high yields (**6a**: 98% yield, **6b**: 84% yield, 7**a**: 71% yield, **7b**: 61% yield), respectively. Primary amine such as butylamine was similarly effective to react with the salts (**4**). Surprisingly, **4** easily reacted with dry acetone at room temperature to afford the 1-acetonylisoselenochromenes (**8**) in high yields (**8a**: 97% yield, **8b**: 83% yield), in spite of the absence of an electron-withdrawing group,[12] which enhanced the reactivity of the hetero-cation ring. This result clearly indicates that acetone operated as an active methyl compound even in the absence of a base catalyst.

In addition, treatment of the salts (**4**) with Grignard reagents, such as methyl-, ethyl-, and phenyl-magnesium bromide (iodide) resulted in carbon-carbon bond formation at the C-1 position to give the 1-alkyl(phenyl)isoselenochromenes (**9**) in 72-80% yields, and the isochromenes (**9**) were furthermore treated with Ph_3C^+ BF_4^- to afford the desired 1-alkyl- or 1-phenyl-2-benzoselenopyrylium tetrafluoroborates (**10**) in 70-80% yields.

Further studies on details of the reactivities of not only these 2-benzoselenopyrylium salts (**4**) but also the 2-benzotelluropyrylium salts are in progress.

REFERENCES AND NOTES

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9. All new compounds exhibited satisfactory analytical and spectroscopic data. Selected data for **3a**: yellow prisms, mp 69-71 ℃ (from *n*-hexane). ^{1}H-NMR ($CDCl_3$, 90 MHz): 1.29 (9H, s, *t*-Bu), 3.76 (2H, s, 1-H_2), 6.70 (1H, s, 4-H), 7.12-7.26 (4H, m, Ph-H). HRMS *m/z*: Calcd for $C_{13}H_{16}Se$: 252.0418. Found: 252.0414. **3b**: yellow oil.
10. Selected data for **4a**: yellow prisms, mp 182-184 ℃ (from acetonitrile-ether). ^{1}H-NMR (CD_3CN, 400 MHz): 1.70 (9H, s, *t*-Bu), Ph-H [8.11 (1H, dd, *J*=8.8, 6.6), 8.43 (1H, d, *J*=7.3), 8.48 (1H, dd, *J*=7.3, 6.6), 8.54 (1H, d, *J*=8.8)], 9.06 (1H, s, 4-H), 11.96 (1H, s, 1-H). ^{13}C-NMR (CD_3CN, 100 MHz): 32.31 (q), 42.36 (s), 132.41 (d), 132.80 (d), 133.49 (d), 134.41 (d), 135.34 (s), 141.62 (d), 142.16 (s), 177.82 (s), 181.22 (d). *Anal.* Calcd for $C_{13}H_{15}BF_4Se$: C, 46.33; H, 4.49. Found: C, 46.21; H, 4.46. **4b**: yellow prisms, mp 127 ℃ (from acetonitrile-ether).
11. Selected data for **5a**: yellow oil. ^{1}H-NMR ($CDCl_3$, 90 MHz): 1.32 (9H, s, *t*-Bu), 3.31 (3H, s, 1-OMe), 5.76 (1H, s, 1-H), 6.90 (1H, s, 4-H), 7.27-7.34 (4H, m, Ph-H). HRMS *m/z*: Calcd for $C_{14}H_{18}OSe$: 282.0523. Found: 282.0525.
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