CONVERSION OF ALLYL ARYL SELENIDES INTO SELENOCHROMAN DERIVATIVES

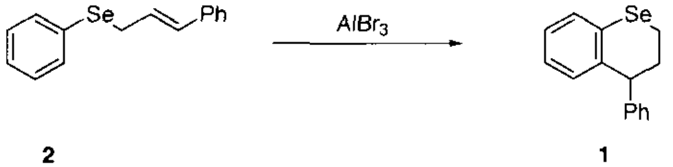
Hitoshi Abe,* Natsuko Koshiba, Akira Yamasaki, and Takashi Harayama*

Faculty of Pharmaceutical Sciences, Okayama University,
Okayama 700-8530, Japan

Abstract – Several allyl aryl selenides were prepared and examined their reactions with aluminum bromide to give selenochroman derivatives in high to moderate yields. A plausible mechanism of this reaction is also discussed.

Heterocyclic compounds containing a selenium atom have attracted much attention in recent years because of their high reactivity and unique chemical properties.[1] The chemistries of selenium-containing molecules, as well as the tellurium analogs, have been intensively studied.[2] However, compared with sulfur heterocyclic compounds,[3] the preparative methods for selenium-containing heterocyclic molecules are quite limited. For example, only a few methods for the preparation of benzoselenane derivatives such as selenochromans and isoselenochromans have been reported.[4]

In our previous studies,[5,6] we demonstrated that when cinnamyl alcohol was treated with a reagent system of phenyl trimethylsilyl selenide – aluminum bromide in dichloromethane, 4-phenylselenochroman (**1**) was obtained as an unexpected product.[5] It was also found that this transformation involved the conversion of cinnamyl phenyl selenide (**2**) into **1** with the aid of aluminum bromide (Scheme 1).[5]



2 **1**

Scheme 1

In order to generalize this convenient transformation of an allyl aryl selenide into a selenochroman, we prepared several allyl aryl selenides and examined their reactions in the presence of a Lewis acid. In preliminary experiments, aluminum bromide gave the best results as the additive compared to the other acids, such as $AlCl_3$, $ZnBr_2$, $Yb(OTf)_3$, $Sc(OTf)_3$, and *p*-toluenesulfonic acid. The other reaction conditions were optimized as shown in Table 1.

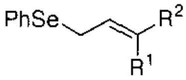
Allyl phenyl selenides (**3–13**) were prepared from allylic alcohols or allylic halides by nucleophilic substitution reactions[7] with the phenylseleno group. The reactions of these substrates in the presence of

Table 1

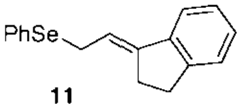
$$\text{Allyl Phenyl Selenide} \xrightarrow[\text{CH}_2\text{Cl}_2,\ \text{r t}]{\text{AlBr}_3} \text{Selenochroman}$$

Allyl Phenyl Selenide	Reaction Time	Selenochroman	Yield (%)
2	2 h	**1**	75 [a]
3	5 min	**14**	92
4	5 min	**14**	94
5	3 h	– [b]	0
6	5 min	**15**	68
7	5 min	– [c]	0
8	5 min	**16**	58
9	2 h	**17**	43
10	5 min	**18**	71
11	5 min	**19**	49
12	5 min	**20**	85
13	5 min	**20**	67

a) See ref. 5. *b*) 86% of **5** was recovered. *c*) Complicated mixture was obtained.



3: R^1 = Me, R^2 = Ph
4: R^1 = Ph, R^2 = Me
5: R^1 = H , R^2 = H
6: R^1 = H , R^2 = *p*-Cl-C_6H_4
7: R^1 = H , R^2 = *p*-EtO-C_6H_4
8: R^1 = H , R^2 = *o*-EtO-C_6H_4
9: R^1 = Me, R^2 = Me
10: R^1 = Ph, R^2 = Ph



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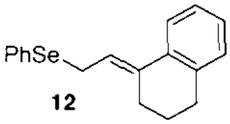

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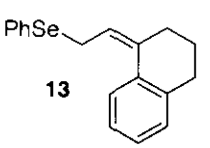

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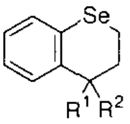
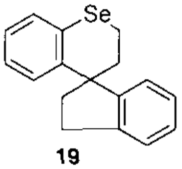


14: R^1 = Me, R^2 = Ph
15: R^1 = H , R^2 = *p*-Cl-C_6H_4
16: R^1 = H , R^2 = *o*-EtO-C_6H_4
17: R^1 = Me, R^2 = Me
18: R^1 = Ph, R^2 = Ph



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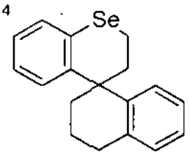

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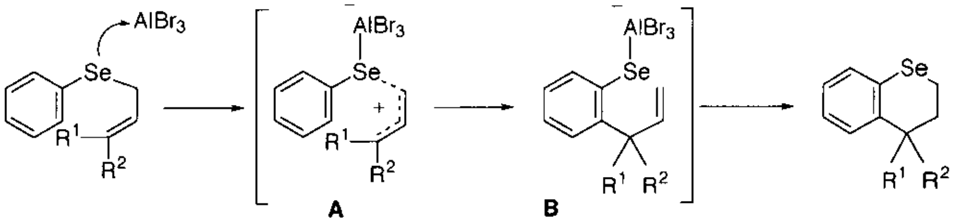
$AlBr_3$ at room temperature smoothly proceeded to afford the corresponding selenochromans in high to moderate yield, with the exception of **5** and **7** (Table 1). The cinnamyl type selenides (**3**, **4**, **6**, **8**, and **10**–**13**) generally showed good reactivity whereas the simple allyl selenide (**5**) did not give any products and was recovered in 86% yield. The low yield of **19** may be due to its unstability under the given reaction conditions. A quaternary carbon center at the benzylic position could be efficiently constructed in this reaction (**14** and **17**–**20**).

We suppose that this reaction pathway can be explained as shown in Scheme 2.[8] Initial coordination of selenium atom to aluminum bromide activates the allylic selenide to generate a positively charged allyl group (**A**). Then the Friedel-Crafts type C-C bond formation between the aromatic ring and the allyl group, followed by nucleophilic attack of aluminum selenolate (**B**) to the olefinic carbon leads to the selenochroman. Further studies on the mechanistic aspect of this selenochroman synthesis are under way.



Scheme 2

Typical Experimental Procedure

To a stirred mixture of freshly purified $AlBr_3$ (46.4 mg, 0.17 mmol) and dry CH_2Cl_2 (0.7 mL), a solution of **3** (50.0 mg, 0.17 mmol) in dry CH_2Cl_2 (1.3 mL) was added under an argon atmosphere. After 5 min at ambient temperature, the reaction mixture was poured into a 1 N NaOH aqueous solution and extracted with CH_2Cl_2. The organic layer was washed with brine, dried over anhydrous $MgSO_4$, and concentrated *in vacuo*. The crude product was then purified on silica gel. Elution with hexane afforded 46.2 mg of **14** (92%) along with a trace amount of diphenyl diselenide.

3,4-Dihydro-4-methyl-4-phenyl-2*H*-benzoselenin (**14**): Yellow oil. IR ($CHCl_3$) 2960, 1595, 1585, 1490, 1470, 1440, 1425, 1375, 1025, 905. ^{1}H-NMR (200 MHz, $CDCl_3$) δ: 1.73 (s, 3H), 2.15 (ddd, 1H, J = 14.0, 9.8, 3.8), 2.50 (ddd, 1H, J = 14.0, 7.4, 3.6), 2.72 (ddd, 1H, J = 11.2, 9.8, 3.8), 2.95 (ddd, 1H, J = 11.2, 7.4, 3.6), 6.98–7.16 (m, 5H), 7.16–7.32 (m, 4H). ^{13}C-NMR (50 MHz, $CDCl_3$) δ: 16.2, 29.1, 39.3, 43.2, 124.8, 126.0, 126.6, 127.1, 128.0, 128.1, 129.0, 129.3, 143.3, 148.2. ^{77}Se-NMR (38 MHz, $CDCl_3$) δ: 220.0. MS (EI) m/z: 284, 285, 286, 288 (^{80}Se, M^+), 290. (1:1:2.5:5:1) *Anal.* Calcd for $C_{16}H_{16}Se$: C, 66.90; H, 5.62. Found: C, 66.83; H, 5.66.

ACKNOWLEDGMENT

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