A Facile Preparation of Aliphatic and Aromatic Primary Selenoamides Using 4-Methylselenobenzoate as a New Selenating Reagent

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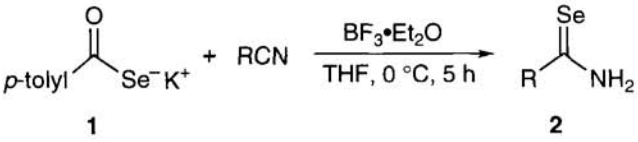
Aliphatic and aromatic primary selenoamides **2** were isolated by the reaction of the corresponding aliphatic and aromatic nitriles with potassium 4-methylselenobenzoate in the presence of $BF_3 \cdot Et_2O$ in moderate from high yields.

Primary selenoamides are regarded as intermediates of selenium- and nitrogen-containing heterocycles.[1] Therefore, some attempts for the synthesis of primary selenoamides have been described. In general, primary selenoamides have been prepared by the treatment of hydrogen selenide, which is highly toxic and air sensible, with the corresponding nitriles. In earlier investigations,[2] hydrogen selenide was directly bubbled into the reaction vessel, however, the yields were low. In recent investigations,[3] hydrogen selenide formed in reacting vessel from its precursor such as Al_2Se_3, NaHSe, and Se and CO was used as a reactant and better results were obtained in case of the preparations of aromatic selenoamides. In addition, a new selenating reagent such as $(Me_3Si)_2Se$ are also used in these preparations.[4] However, almost of these methods required prolonged reaction times, high temperature or inconvenience reaction conditions. Selenocarboxylic acids are very unstable, while the metal salts are fairly stable.[5] In the previous paper,[6] we have described a convenient synthesis of potassium selenocarboxylates, which are stable in atmosphere and handled on desk. The salts are useful as starting material for preparations of the derivatives. In this paper, we now report BF_3-promoted potassium 4-methylselenobenzoate **1** functions for a reagent of introducing selenium to aliphatic or aromatic nitriles to give the corresponding primary selenoamides **2** under mild reaction conditions.



Scheme 1.

A typical procedure for the reaction of potassium 4-methylselenobenzoate with hexanenitrile is follows: To the suspension of potassium 4-methylselenobenzoate (1 mol) and excess hexanenitrile (5 mol) in THF was added $BF_3 \cdot Et_2O$ (1.2 mol) at 0 °C under argon atmosphere. The mixtures immediately became a clean reddish violet solution. And then the reaction mixture was stirred at this temperature for 5 h. After ordinary procedures, the residue was chromatographed on silica gel column to yield 96% of hexaneselenoamide.[7] The reaction with an equimolar hexanenitrile gave hexaneselenoamide in a low yield (46%). The excess nitrile in this procedure was easily recovered with column chromatography.

In a similar manner, the reactions of potassium 4-methylselenobenzoate with various aliphatic and aromatic nitriles in THF at 0 °C afforded the corresponding selenoamides **2** in moderate from high yields. The results were listed in Table 1. The structures of the selenoamides were confirmed by studies of IR, ^1H and ^{13}C NMR, and MS spectroscopy and HRMS analyses.

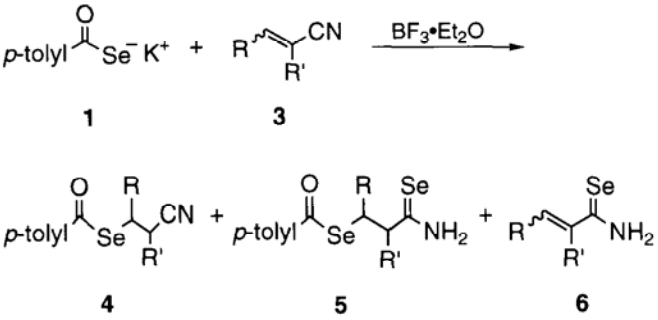
Table 1. Yields of aliphatic and aromatic selenoamides

	R	Yield /%[a]		R	Yield /%[a]
2a	$C_6H_5CH_2$	77	**2f**	C_6H_5	72
2b	iso-C_3H_7	41	**2g**	2-$CH_3C_6H_4$	63
2c	n-C_4H_9	70	**2h**	4-$CH_3C_6H_4$	75
2d	tert-C_4H_9	65	**2i**	4-$CH_3OC_6H_4$	65
2e	n-C_5H_{11}	96	**2j**	2-ClC_6H_4	76
			2k	4-ClC_6H_4	86

[a] Isolated yield based on potassium 4-methylselenobenzoate.

In previously, a few aliphatic primary selenoamides had been synthesized, however the results were low yields or not isolated.[2,3] The present procedure was applied successfully to various nitriles processing not only aromatic but also aliphatic substituents. Further, the yields were satisfactory even sterical hindered selenoamides such as **2d**, **2g**, **2j**.

The reaction of acrylonitrile with the selenocarboxylate **1** gave Michael type product **4a** as a main product. And 2-selenocarbamoylethyl 4-methylselenobenzoate **5a**, which contained two selenium atom, was also obtained as minor product. α,β-Unsaturated selenoamide **6a** was not obtained (Scheme 2). Similarly, the reactions with methacrylonitrile, crotononitrile and



Scheme 2.

Table 2. Reaction of **1** with α,β-unsaturated nitriles **3**

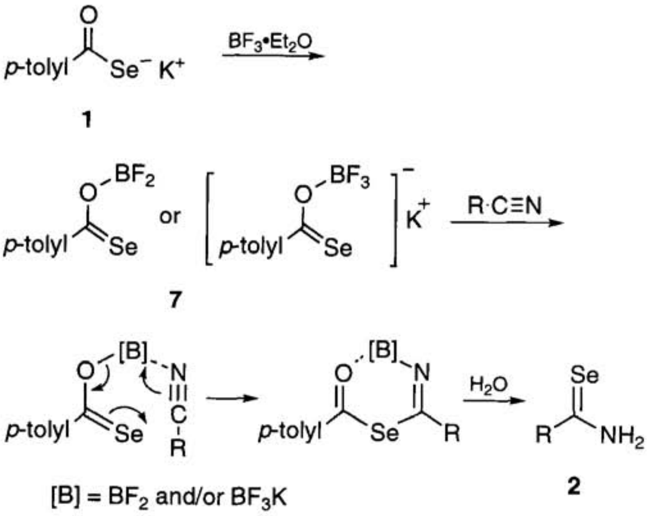
	Nitrile **3**		Yield /%[a]		
	R	R'	**4**	**5**	**6**
a	H	H	71	14	0
b	H	CH_3	34	20	0
c	CH_3	H	41	15	0
d	C_2H_5	H	34	25	0
e	C_6H_5	H	18	0	15

[a] Isolated yield based on potassium 4-methylselenobenzoate.

cis-2-pentenenitrile gave same results (Table 2). On the other hand, the same reaction with cinnamonitrile gave both Michael type product **4e** and α,β-unsaturated selenoamide **6e** in low yields.

The reaction of cyclohexanone with the selenocarboxylate **1** in the presence of $BF_3 \cdot Et_2O$ gave bis(4-methylbenzoyl) diselenide in high yield. Probably the diselenide results from labile products of this reaction.

In these preparations, selenoamide was not obtained in absence of $BF_3 \cdot Et_2O$. When the suspension of potassium 4-methylselenobenzoate in THF added an equimolar of $BF_3 \cdot Et_2O$, the reaction mixture turned to reddish violet from dark green. ^{13}C NMR spectrum of the resulting mixture (solvent : THF-d10) showed at δ = 220.9 and 221.3, which is assigned to selenocarbonyl carbon,[8] and disappeared a peak by carbonyl carbon of selenocarboxylate (δ = 190). In addition, formation of selenocarbonyl function was also shown that the lower field peaks at δ = 1645 and 1653 was observed in ^{77}Se NMR spectrum. These results[9] would be shown that the reaction can be reasonable explained by considering an initial formation of selenone complex **7** from potassium 4-methylselenobenzoate and boron trifluoride in tetrahydrofuran. Nucleophile attack of the resulting selenium atom of selenone to nitlile and then hydrolysis would give primary selenoamide as shown in Scheme 3.



Scheme 3.

Summarizing, we have developed a convenient preparation of aliphatic and aromatic selenoamides from nitrile and BF_3-promoted potassium 4-methylselenobenzoate under mild conditions.

References and Notes

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7 When the temperature of the reaction mixture was raised to 25 °C, or lowered to -20 °C, the yields of hexaneselenoamide were 24 and 34%, respectively. Further, when dichloromethane, chloroform or benzene was used as a solvent instead of THF, the yield of the selenoamide was low.

8 The observation of two peaks assigned selenocarbonyl function presumably suggests to exist two selenone complexes such as **7** in Scheme 3.

9 When $TiCl_4$, $SnCl_4$ or $AlCl_3$ was used in place of $BF_3 \cdot Et_2O$, the color of the resulting mixture did not turned to reddish violet and ^{13}C and ^{77}NMR spectra of the mixture did not caused downshift.