Ozonolysis of Olefinic Phenyl Selenides with Preservation of the Selenium Unit: A Route to Phenylseleno Aldehydes and Ketones

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Ozonolysis and reductive workup, both at a low temperature, serve to convert alkenyl phenyl selenides into carbonyl compounds that retain the phenylseleno group.

As is well known, the phenylseleno group plays an important role in the preparation of olefins[1] and in synthetic radical chemistry,[2] but there are a few potential limitations on its use. In particular, this group is not expected to survive conditions for hydrogenation,[3] and the oxidation of alcohols in its presence is restricted to a small set of reagents.[4] These facts, of course, must be taken into account when choosing the proper stage of a synthetic sequence at which to introduce the phenylseleno group. We report that the double bond of olefinic phenyl selenides may be cleaved easily by ozonolysis with preservation of the phenylseleno group [eqn. (1)]; this selective transformation is possible even though (*i*) ozone reacts with selenides more rapidly than with olefins[5] and (*ii*) exposure of alkyl phenyl selenides to ozone, followed by warming, is one of the standard methods for converting selenides into (selenium-free) olefins.[1]

$$\text{PhSe–C–(C)}_{\bar{n}}\text{C=C–C} \xrightarrow[\text{ii, Ph}_3\text{P}]{\text{i, O}_3} \text{PhSe–C–(C)}_{\bar{n}}\text{CHO} \qquad (1)$$

Each of the olefinic selenides **1a**–**6a** was treated with an excess of ozone under conditions (−78 °C, CH_2Cl_2) that cleave the double bond and convert the PhSe unit into the corresponding selenoxide.[5] Then, a mild reducing agent (3–4 mol per mol substrate; we have examined only triphenylphosphine[6]) is introduced and the mixture is allowed to attain room temperature over 4–5 h. In these circumstances the ozonide (or related species[7]) from the carbon–carbon double bond and the selenoxide are both reduced, the latter process being more rapid than selenoxide fragmentation. The examples given show that yields in this sequence are quite good.†

Compounds **1a**–**3a**, and **6a**, are primary selenides and, as this is a structural type known[1,8] to afford phenyl selenoxides that fragment slowly, we also examined the secondary selenides **4a** and **5a**. In the case of **4a**, fragmentation of the derived selenoxide is expected to be especially easy since a conjugated system is thereby formed. However, even in this demanding case the method of low-temperature ozonolysis followed by low-temperature reduction does still work, the modest yield being partly a reflection of the instability of **4b** on chromatography.‡ The other secondary selenide (**5a**), in contrast, behaves well and is cleaved efficiently.

Our results show that the phenylseleno group tolerates ozonolysis conditions, and so this group may be introduced in a synthetic sequence prior to any necessary double bond cleavage. Certain synthetic schemes can thereby by simplified and, in point of fact, the present route to **6b** is more efficient than approaches we tried where either the phenylseleno group was to be introduced after formation of the aldehyde carbonyl, or where another synthetic equivalent of the aldehyde pendent [$BrCH_2CH(OMe)_2$[9]] was used.

Compounds **1a**–**4a** were made by Wittig olefination from **1b**–**4b**, and these substances, in turn, were generated by reduction ($Bu^i{}_2AlH$) of the corresponding esters (for **1b**–**3b**) or by conjugate addition of benzeneselenol to cyclohex-2-enone[10] (for **4b**). Selenide **5a** was obtained from 6-methylhept-5-en-2-ol[11] by treatment with $PhSeCN–Bu_3P$[12] (CH–OH → CHSePh), and ester **6a** was made analogously to the corresponding $\Delta^{4,5}$-compound.[13]

All new compounds were fully characterized by spectroscopic methods and by combustion analysis.

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Footnotes

† *Typical procedure*: Ozonized oxygen (precooled to −78 °C) was bubbled through a cold (−78 °C) solution of **2a** (143.7 mg, 0.601 mmol) in dry CH_2Cl_2 (35 ml) until a blue colour persisted (*ca.* 5 min). Triphenylphosphine (500 mg, 1.90 mmol) was added in one portion and the solution was stirred under argon. The cooling bath was left in place, but allowed to attain room temperature (4–5 h). Evaporation of the solvent and flash chromatography of the residue over silica gel (2.5 × 18 cm), using 10% EtOAc–hexane, gave aldehyde **2b** (134.4 mg, 93%), spectroscopically identically to an authentic sample.

‡ Examination of pure **5b** by two-dimensional TLC (silica) showed that the compound suffers partial decomposition on silica gel, and preparation flash chromatography leads to a 10% loss of material.

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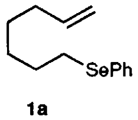
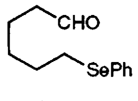
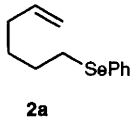


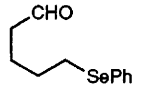
1a



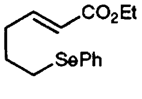
1b (84%)



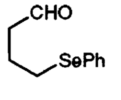
2a



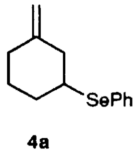
2b (93%)



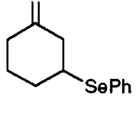
3a



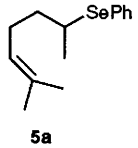
3b (83%)



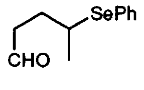
4a



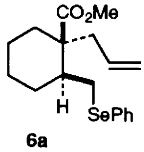
4b (50%)



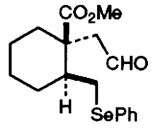
5a



5b (76%)



6a



6b (82%)

Yields refer to pure isolated materials

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