[Chem. Pharm. Bull. 30(4)1493—1495(1982)]

Some Aspects of the Reaction of Phenylselenomagnesium Bromide with Carbonyl Compounds

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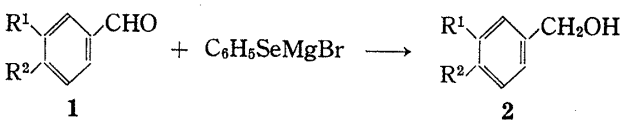
(Received September 21, 1981)

The reactivity of phenylselenomagnesium bromide with some carbonyl compounds has been studied. It was found that aromatic aldehydes were reduced to give the corresponding alcohols, and aliphatic aldehydes and ketones which have active hydrogens were found to afford condensed products.

Keywords——reactivity of phenylselenomagnesium bromide; reduction of aromatic aldehydes; condensing agents; organoselenium compounds; synthesis of aromatic alcohols

Recently, many types of reaction involving organoselenium compounds have been reported and some of them have provided synthetically useful methodology.[1] As part of our continuing work on the development of new synthetic applications of organoselenium compounds,[2] we have investigated the reactivity of phenylselenomagnesium bromide[3] with various types of carbonyl compounds and found that aromatic aldehydes were converted into the corresponding alcohols in moderate yields as shown in Table I.

TABLE I. Reaction of Phenylselenomagnesium Bromide with Aldehydes[a]



1 2

Aldehyde (1)	Alcohol (2)	Yield (%)	bp/Torr or mp	Literature data
1a: $R^1=R^2=H$	**2a**	36.9	bp 80—85°C/5Torr	bp 104—105°C/20 Torr[4]
1b: $R^1=H$, $R^2=OMe$	**2b**	48.1	mp 24—25°C	mp 24°C[5]
1c: $R^1=R^2=OMe$	**2c**	29.4	bp 150—155°C/5 Torr	bp 157—160°C/5 Torr[6]
1d: $R^1=OMe$, $R^2=OCH_2C_6H_5$	**2d**	42.9	mp 97—98°C	mp 96—97°C[7]
1e: $R^1+R^2=$ 	**2c**	56.1	mp 53—54°C	mp 54—55°C[8]

a) All the reactions were carried out at room temperature for 13 h by using about 3 equimolar amounts of phenylselenomagnesium bromide in tetrahydrofuran.

This novel reaction of phenylselenomagnesium bromide with aldehydes could be well explained by the reaction mechanism shown in Chart 1.

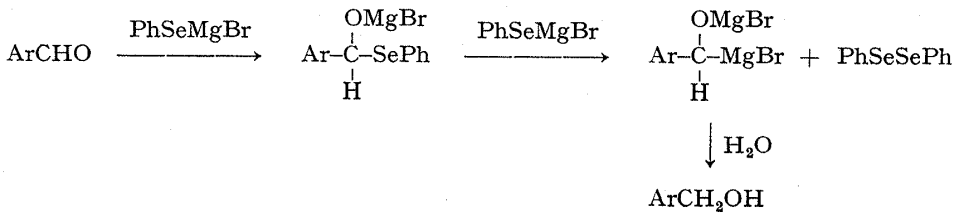


Chart 1

Next, the reactivity of phenylselenomagnesium bromide toward *n*-heptaldehyde (**3**), acetophenone (**4**), and *m*-methoxyacetophenone (**5**), which have active hydrogens, was explored under the same conditions as above. Although the reactions in these cases were sluggish, the condensed compounds (**6**) and (**7**) from (**3**), (**9**)[9] and (**10**) from (**4**) and (**5**), respectively, were obtained in low yields. Compound (**7**) was dehydrated to give (**8**) for structure determination. This condensation reaction could be interpreted in terms of the basic character of phenylselenomagnesium bromide. The formation of **6** could also be understood as the vinylogous case of (**1**) through the intermediate (**8**), which was derived by dehydration of the compound (**7**) formed by aldol condensation of **3**.

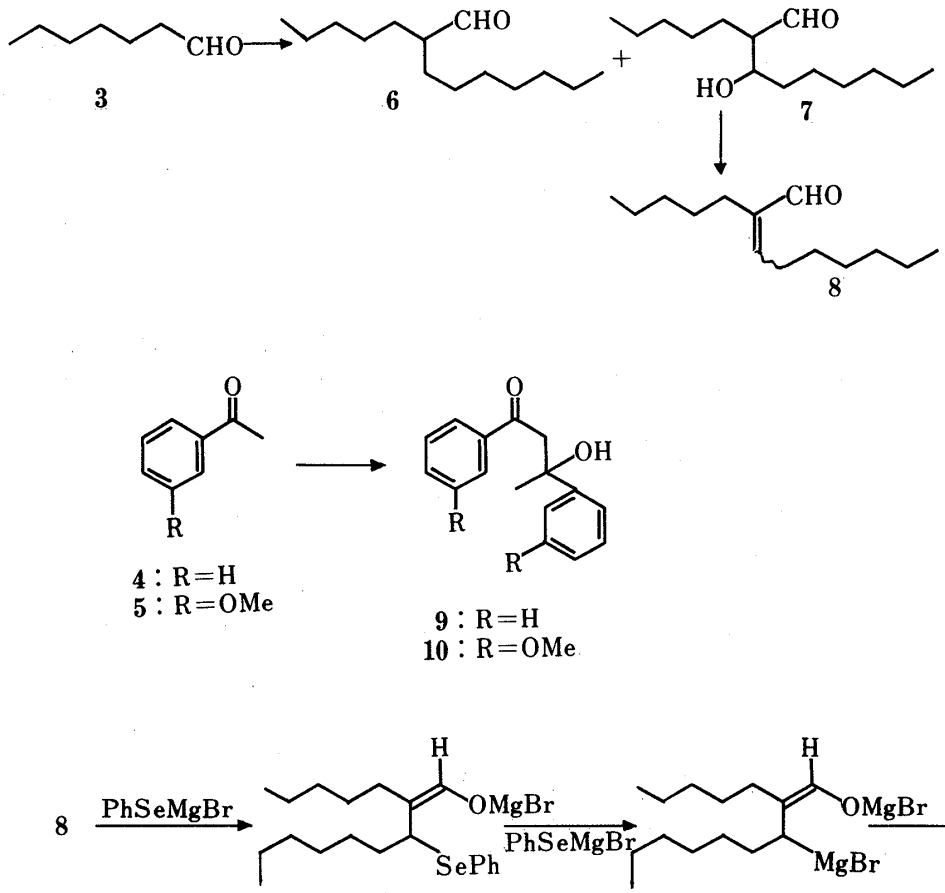


Chart 2

Thus, it could be concluded that phenylselenomagnesium bromide reacted with aromatic aldehydes to afford the corresponding alcohols by acting as a reducing agent, whereas with aliphatic aldehydes or aromatic ketones having active hydrogens it acts as a base to give the condensed products.

Experimental

Infrared (IR) spectra were measured on a Hitachi EPI-3 spectrophotometer. Nuclear magnetic resonance (NMR) spectra were taken on a JEOL JNM-PMX-60 spectrometer. Mass spectra (MS) were measured on a Hitachi M-52G spectrometer.

General Procedure for the Reaction of Phenylselenomagnesium Bromide with Carbonyl Compounds—To a stirred solution of an aldehyde (**1**) (20 mmol) in 40 ml of anhydrous tetrahydrofuran was added 60 ml of 1 mol solution of phenylselenomagnesium bromide in ether at room temperature. After 13 h, the reaction mixture was quenched with 40 ml of water and extracted three times with 100 ml portions of ether. The combined organic extracts were washed with 100 ml of saturated sodium chloride solution and dried over anhydrous sodium sulfate. Removal of the solvent by evaporation afforded a crude product, which was

subjected to distillation under reduced pressure to give a pure sample of the corresponding alcohol (**2**) in the yield shown in Table I.

Reaction of *n*-Heptaldehyde (3) with Phenylselenomagnesium Bromide——*n*-Heptaldehyde (**3**) (255 mg, 2.24 mmol) was reacted with phenylselenomagnesium bromide by following the general procedure described above and the crude product obtained was chromatographed on silica gel (20 g) with the hexane: benzene (4: 1) as the eluent. After removal of the solvent from the first fraction, the residue was collected to afford (**6**) (61 mg, 12.9%) as a colorless oil. *Anal.* Calcd for $C_{14}H_{28}O \cdot CH_2Cl_2$: C, 75.50; H, 12.67. Found: C, 75.83; H, 12.51. IR $\nu_{max}^{CHCl_3}$ cm^{-1}: 1720; NMR (CCl_4) δ: 9.45 (1H, d, J=3 Hz, CHO). MS *m/e*: 212 (M^+).

Removal of the solvent from the second fraction gave (**7**), which was treated with a catalytic amount of *p*-toluenesulfonic acid in benzene under reflux to yield (**8**) as a colorless oil (19 mg, 4%). *Anal.* Calcd for $C_{14}H_{26}O \cdot 0.3H_2O$: C, 77.93; H, 12.43. Found: C, 77.91; H, 12.35. IR $\nu_{max}^{CHCl_3}$ cm^{-1}: 1680; NMR (CCl_4) δ: 2.0—2.57 (4H, m, $-CH_2-\underset{|}{C}=\underset{|}{C}-CH_2-$), 6.3 (1H, t, J=7 Hz, $>C=CH-$), 9.27 (1H, s, CHO); MS *m/e*: 210 (M^+).

Reaction of Acetophenone (4) with Phenylselenomagnesium Bromide——Acetophenone (**4**) (240 mg, 2 mmol) reacted with phenylselenomagnesium bromide to give a crude product which was chromatographed on silica gel (5 g) with hexane: ethyl acetate (5: 1) as the eluent. Removal of the solvent by evaporation afforded (**9**) (119 mg, 48.2%) as a colorless oil which was crystallized from hexane. mp 64—65°C.[10] IR $\nu_{max}^{CHCl_3}$ cm^{-1}: 3500, 1670; NMR(CCl_4) δ: 1.55 (3H, s, CH_3), 3.15 (1H, d, J=18 Hz, $CO-\underset{\underline{H}}{\overset{H}{\underset{|}{\overset{|}{C}}}}-$), 3.6 (1H, d, J=18 Hz, $CO-\underset{\underline{H}}{\overset{H}{\underset{|}{\overset{|}{C}}}}-$), 4.65 (1H, br s, OH), 7.0—8.0 (10H, m, Ar<u>H</u>); MS *m/e* 240 (M^+).

Reaction of *m*-Methoxyacetophenone (5) with Phenylselenomagnesium Bromide——*m*-Methoxyacetophenone (**5**) (450 mg, 3 mmol) reacted with phenylselenomagnesium bromide to yield a crude product which was chromatographed on silica gel (5 g) with hexane:ethyl acetate (5: 1) as the eluent. Removal of the solvent afforded (**10**) (59 mg, 26%) as a colorless oil. IR $\nu_{max}^{CHCl_3}$ cm^{-1}: 3500, 1760; NMR (CCl_4) δ: 1.55 (3H, s, CH_3), 3.15 (1H, d, J=18 Hz, $CO-\underset{\underline{H}}{\overset{H}{\underset{|}{\overset{|}{C}}}}-$), 3.55 (1H, d, J=18 Hz, $CO-\underset{H}{\overset{\underline{H}}{\underset{|}{\overset{|}{C}}}}-$), 3.73 (3H, s, OCH_3), 3.75 (3H, s, OCH_3), 6.45—7.4 (8H, m, Ar<u>H</u>), high-resolution mass spectrum, Calcd for $C_{18}H_{20}O_4$ *m/e* 300.1360. Found: *m/e* 300.1333.

Acknowledgement We thank Miss Y. Enomoto, Mrs. C. Koyanagi, Mr. K. Kawamura, Pharmaceutical Institute, Tohoku University, for microanalyses and spectral measurements and for preparation of the manuscript.

References and Notes

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