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Novel Reaction: Brominative Aromatization of 2-Alkyl(aryl)thio Cyclohexanones

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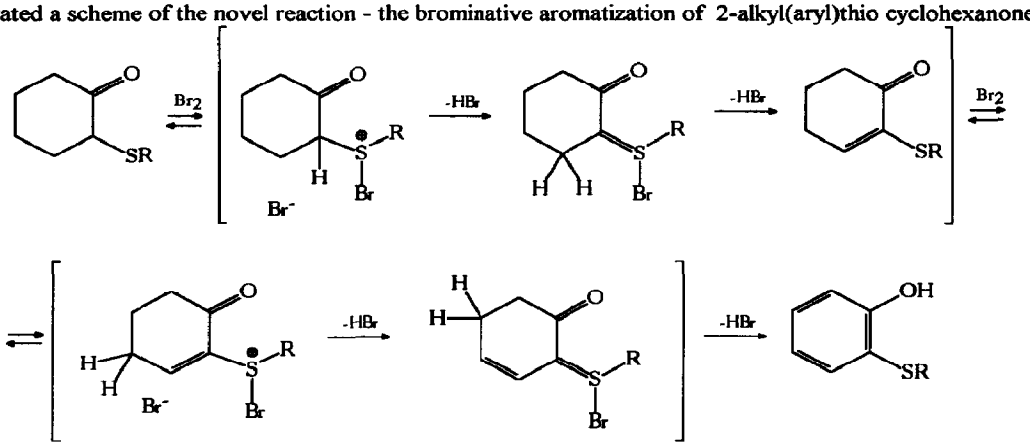
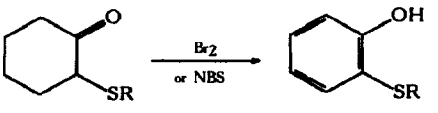
***Abstract**: 2-Alkyl(aryl)thio cyclohexanones are transformed into o-alkyl(aryl)thio phenols by treatment with bromine or N-bromosuccinimide.*

Sulfur in organic molecules is often used as 'supporting element' [1] for various synthetic purposes [1,2] For example, the sulfur atom can act as a receptor for bromine at the first stage of brominative aromatization of 1,2-bis(alkylthio)cyclohexenes [3] and cyclohexeno-5,6-dihydro-1,4-dithiines and -1,4-oxathiines [3,4] (the same reaction can be carried out also for thioethylene acetals of cyclohexanone and its derivatives *via* rearrangement into corresponding 5,6-dihydro-1,4-dithiines and -1,4-oxathiines [4-6]). Starting from this basic idea [4] we elaborated a scheme of the novel reaction - the brominative aromatization of 2-alkyl(aryl)thio cyclohexanones:



This reaction has been accomplished for a series of 2-RS-cyclohexanones and has afforded the expected results. The experimental procedure is very simple and rather effective: the starting ketones are treated with 2 equivalents of bromine (method A) or NBS (method B) in chloroform or carbon tetrachloride (0 °C), then stirred for several hours at room temperature and refluxed if necessary until the reaction is completed (t.l.c.).



1-4

o-(RS)-phenol	**1**	**2**	**3**	**4**
R	*n*-C_4H_9	*c*-C_6H_{11}	C_6H_5	*o*-$O_2NC_6H_4$
Yield, % (method)	80 (A)	81 (A), 78 (B)	92 (A), 80 (B)	70 (A)

To the best of our knowledge this transformation has never been observed previously. As the nearest analogy could be considered the aromatization of mono(dithioethyleneacetal) of 1,4-cyclohexanedione *via* intermediate formation of 4'-oxocyclohexeno-5,6-dihydro-1,4-dithiine. [4]

Our present investigation provides the new example of the use of alkyl(aryl)thio groups as 'internal auxiliaries' in organic synthesis. This reaction can be used as a mild and convenient method for (a) the transformation of various cyclohexanones *via* 2-halo- and 2-RS-derivatives into corresponding *o*-RS-phenols (with possible subsequent elimination of RS-groups), (b) the S-arylation (hydroxyarylation) of thiols, and (c) the synthesis of variously substituted aromatic thiols. All these possibilities are now under active investigation.

EXPERIMENTAL SECTION

NMR spectra were recorded on Varian VXR-400 instrument (400 MHz for ^1H and 100 MHz for ^{13}C) in $CDCl_3$-CCl_4 (1:1) solutions.

2-RS-cyclohexanones were prepared by treatment of 2-chlorocyclohexanone with equivalent amount of KSR in 95% ethanol according to the reported procedure. [7] *o-(n-Butylthio)phenol* **1**: b.p. 97-98 °C (2 mm Hg); ^1H NMR: 7.45 (d, 1H, J = 7.8 Hz), 7.24 (t, 1H, J = 7.8 Hz), 6.98 (d, 1H, J = 7.8 Hz), 6.85 (t, 1H, J = 7.8 Hz), 6.74 (s, 1H), 2.69 (t, 2H, J = 7.5 Hz), 1.54 (m, 2H), 1.43 (m, 2H), 0.92 (t, 3H, J = 7.5 Hz). ^{13}C NMR: 157.07, 135.92, 130,93, 120.55, 119.11, 114.76, 36 51, 31.75, 21.78, 13.69; IR: 3400 cm^{-1}; m/e = 182 (M^+). *o-(Cyclohexylthio)phenol* **2:** b.p. 127-129°C (2 mm Hg); ^1H NMR: 7.39 (d, 1H, J = 7.8 Hz), 7.22 (t, 1H, J = 7.8 Hz), 6.94 (d, 1H, J = 7.8 Hz), 6.81 (t, 1H, J = 7.8 Hz), 6.77 (s, 1H), 2.82 (m, 1H), 1.96 (m, 2H), 1.82 (m, 2H), 1.31 (m, 6H); ^{13}C NMR: 157.62, 136.86, 131.15, 120.27, 117.51, 114.64, 48.42, 33.54, 26.13, 25.95; IR: 3420 cm^{-1}; m/e = 208 (M^+). *o-(Phenylthio)phenol* **3**: b.p. 123-125 °C (3 mm Hg) [lit. [8]: b.p. 144-145 °C (4 mm Hg)]; ^1H NMR: 7.54 (d, 1H, J = 8 Hz), 7.39 (t, 1H, J = 8 Hz), 7.24 (m, 2H), 7.16 (m, 1H), 7.08 (m, 3H), 6.96 (t, 1H, J = 8 Hz), 6.51 (s, 1H); ^{13}C NMR: 157.36, 136.85, 135.91, 132.22, 129.17, 126.81, 126.05, 121.19, 116.26, 115 61; IR: 3420 cm^{-1}; m/e = 202 (M^+). *o-(o-Nitrophenylthio)phenol* **4**: m.p. 95-97 °C (petr. ether) [lit. [9]: 102-104 °C (AcOH-H_2O)]; ^1H NMR: d 8.39 (d, 1H, J = 8.5 Hz), 7.62 (d, 1H, J = 8 Hz), 7.59 (t, 1H, J = 8 Hz), 7.51 (t, 1H, J = 8 Hz), 7.39 (t, 1H, 7 5 Hz), 7.24 (d, 1H, J = 8 Hz), 7.16 (t, 1H, J=7.5 Hz), 6.89 (d, 1H, J = 8.5 Hz), 6 41 (s, 1H); ^{13}C NMR: 157.80, 145.3; 137.32, 136.24, 134.02, 133.45, 127.31, 126.16, 125.74, 121 97, 116.24, 114 42; IR: 1340, 1520, 3300 cm^{-1}; m/e = 247 (M^+).

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