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### A FACILE ALKYLATION OF ARYL ALDEHYDE TRISYLHYDRAZONES WITH TRIALKYLBORANES

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Abstract: Tributylborane readily alkylates aryl aldehyde trisylhydrazones to produce the corresponding alcohols in excellent yields.

Alkylation of carbonyl compounds by organometallic reagents is

one of the most useful tools available to the synthetic organic chemist.

Typically, only active alkylmetals such as organomagnesium<sup>1</sup>,

organolithium<sup>2</sup>, or organozinc<sup>3</sup> reagents are used to achieve this

transformation. Unlike traditional organometallic reagents,

organoboranes tolerate a wide variety of functional groups<sup>4</sup>.

Trialkylboranes, however, do not routinely alkylate carbonyl compounds<sup>5</sup>.

We recently reported a reaction utilizing trialkylboranes that is equivalent to the overall 1,2-addition of an alkyl group to a carbonyl

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#### Scheme 1. Alkylation of Aryl Aldehyde

#### Trisylhydrazones via Tributylborane



compound.<sup>6</sup> Trialkylboranes react with aryl aldehyde trisylhydrazones **1** in the presence of base to produce intermediate **2** (Scheme 1) which is readily oxidized to the corresponding alcohol **3**.

We wish to report that 2,4,6-triisopropylbenzenesulfonylhydrazones undergo the alkylation reaction even more effectively than tosylhydrazones. The 2,4,6-triisopropylbenzenesulfonyl (trisyl) moeity has proven to be superior to the tosyl group in the production of di-imide from arenesulfonylhydrazides<sup>7</sup> and in the production of diazoalkanes from arenesulfonylhydrazones<sup>8</sup>. In our hands, the utilization of aryl

Compound	Oxidant	Time (h)	% Yield <sup>a</sup>		
3a <sup>16</sup>	NaBO <sub>3</sub> 4H <sub>2</sub> O	2	90		
3b <sup>17</sup>	NaBO <sub>3</sub> 4H <sub>2</sub> O	3	80		
3c <sup>18</sup>	NaBO <sub>3</sub> 4H <sub>2</sub> O	1	76		
3d <sup>19</sup>	NaBO <sub>3</sub> 4H <sub>2</sub> O	1	88		
3e	peracetic acid	1	86		
Зf	peracetic acid	1	83		
3g	peracetic acid	1	Ob		
3h	NaBO <sub>3</sub> 4H <sub>2</sub> O	1	91		

Table 1, Synthesis of aryl alcohols 3<sup>a</sup>

<sup>a</sup> Known compounds (**3a** - **d**) exhibited physical and spectral characteristics in accord with literature data. New compounds were characterized by NMR and elemental analysis. <sup>c</sup>Isolated yields based on trisylhydrazone. <sup>b</sup>89% isolated yield of alkane.

aldehyde trisylhydrazones<sup>8</sup>, in place of aryl aldehyde tosylhydrazones, leads to improved yields of **3** under milder reaction conditions (Table 1). The alkylation reaction proceeds readily at room temperature instead of reflux. The onset of the reaction is indicated by vigorous gas evolution.

## **Results and Discussion**

Oxidation of **2** produces alcohol **3** if a non-nucleophilic base is used. The use of a non-nucleophilic base prevents the deboronation of **2** and subsequent protonolysis to the corresponding alkane. The classical hydrogen peroxide - base oxidation procedure cannot be used since benzylboranes such as **2** are easily protonolyzed under those conditions<sup>9</sup>. Use of the milder sodium perborate (NaBO<sub>3</sub>·4H<sub>2</sub>O) oxidation procedure<sup>10</sup> produces the aryl alcohols **3** in good yields. If, however, an electron withdrawing substituent is present on the ring, the sodium perborate procedure primarily produces alkane. Peracetic acid has also been used to oxidize easily protonolyzed organoboranes<sup>11,12</sup>. The use of peracetic acid as oxidant in this reaction increases the yield of alcohol and is the oxidant of choice when electronegative substituents are present on the ring.

This reaction appears to be general for a variety of aryl substituents. It also appears to be insensitive to steric effects present in the trisylhydrazone. The sterically hindered 2,4,6-trimethyl derivative (**3h**), for example, gives an excellent yield of alcohol. Substitution in the ortho, meta, or para positions gives comparable yields of alcohol products in the case of the 4-methoxy substituent (**3b** - **3d**). Trisylhydrazones with electron-withdrawing substituents in the ortho position however, give only alkane products (**3g**). The reason for the production of alkane instead of **3** in this case has not yet been determined.

#### Experimental

The following procedure is representative. In a dry, argon-flushed, round-bottomed flask equipped with a side-arm, reflux condenser, and stirring bar, aryl aldehyde trisylhydrazone (3.0 mmol) was dissolved in dry THF (17 mL). Tributylborane (3.0 mmol, 3.0 mL of a 1.0 <u>M</u> solution in THF) was added via syringe. DBU (3.0 mmol, 0.45 mL) was added and the reaction mixture was stirred at room temperature. Gas evolution

Found (Theoretical)					
Compound	С	Н			
3e	54.91 (54.34)	6.27 (6.22)			
Зf	54.42 (54.34)	6.21 (6.22)			
Зg	54.24 (54.34)	6.20 (6.22)			
3h	81.26 (81.50)	10.80 (10.75)			

 Table 2.
 Elemental analyses of new compounds.

Table 3.	NMR data	of new	compounds	

Cpd	<sup>1</sup> H NMR (ppm)	<sup>13</sup> C NMR (ppm)
Зе	7.46 (d, 2H, J = 8.40 Hz), 7.20 (d, 2H, J = 8.37 Hz), 4.61 (t, 1H, J = 6.61 Hz), 1.99 (br s, 1H), 1.82-1.61 (m, 2H), 1.41-1.18 (m, 4H), 0.88 (t, 3H, J = 6.92 Hz)	143.87, 131.46, 127.6, 121.12, 73.97, 38.79, 27.78, 22.51, 13.93.
Зf	7.45-7.08 (m, 4H), 4.54 (t, 1H, <i>J</i> = 6.57 Hz), 1.96 (br s, 1H), 1.76-1.52 (m, 2H), 1.38-1.10 (m, 4H), 0.82 (t, 3H, <i>J</i> = 6.86 Hz)	147.29, 130.43, 129.95, 129.00, 124.49, 122.54, 73.95, 38.82, 27.78, 22.51, 13.94
Зg	7.57-7.06 (m, 4H), 5.10-5.01 (dd, 1H, J = 4.38, 7.84), 2.12 (br s, 1H), 1.86- 1.61 (m, 2H), 1.54-1.31 (m, 4H), 0.91 (t, 3H, J = 6.98 Hz)	143.92, 132.59, 128.64, 127.64, 127.28, 122.00, 72.90, 37.39, 27.92, 22.50, 13.98.
3h	<sup>1</sup> H-NMR (CDCl <sub>3</sub> /TMS) $\delta$ 6.80 (s, 2H), 5.15-5.06 (dd, 1H, <i>J</i> = 5.67, 8.46 Hz), 2.38 (s, 6H), 2.24 (s, 3H), 2.05-1.88 (m, 1H), 1.77 (br s, 1H), 1.75-1.62 (m, 1H), 1.59-1.20 (m, 4H), 0.90 (t, 3H, <i>J</i> = 7.03 Hz)	137.10, 136.32, 135.92, 130.10, 71.46, 35.52, 28.76, 22.65, 20.66, 13.98.

was noticeable as the reaction progressed. The reaction was stirred until gas evolution ceased and TLC indicated that no starting material was present. The reaction was then oxidized according to published procedures<sup>10-14</sup> and the product extracted into ether. After removal of solvent the product was purified by flash chromatography<sup>15</sup>. Isolated yields range from 76% - 90 %. The NMR spectral data and elemental analyses of the new compounds are summarized in Table 2 and Table 3. **Conclusion** 

The reaction of trisylhydrazones with tributylborane proceeds under mild conditions and leads to high yields of alcohol.

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