AN IMPROVED PROCEDURE FOR THE PREPARATION OF 2,2'-SPIROBI[2H-1-BENZOPYRAN]

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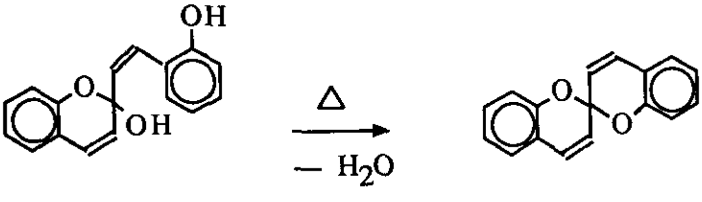
Abstract - A simple and improved procedure for preparing multi-gram quantities of 2,2'-spirobi[2H-1-benzopyran] (**2**) is reported.
The cyclization of the dihydroxybenzopyran intermediate (**1**) into **2** proceeded smoothly when a solution of **1** in 2-ethoxyethyl acetate was heated under reflux for 3 hours.

There has been considerable interest in the chemistry of 2H-1-benzopyran ring system (more commonly referred to as chrom-3-enes) over the past few years.[1,2] A number of naturally occurring compounds contain a 2,2-dialkylchromene ring system[3] and the spirobenzopyrans, in particular, exhibit photochromism or thermochromism.[4] Related to our interest in the chemistry of heterocyclic ene systems, we needed multi-gram quantities of 2,2'-spirobi[2H-1-benzopyran] (**2**). Herein, we report a convenient preparation of **2** via the intermediate (**1**) starting from salicyl aldehyde and acetone.



1 **2**

Bergmann et al.[5] reported the experimental details for the preparation of **2** via **1**. Reaction of salicyl aldehyde with acetone in the presence of sodium hydroxide followed by acid treatment was reported to provide **1** in 60% yield. We were able to prepare the intermediate (**1**) in 50 g scale by following the reported procedure without any difficulty. The conversion of **1** into **2**, however, proved to be difficult in 10-20 g scale when the literature procedure was followed as reported. The authors have reported that the conversion of **1** into **2** was best effected by heating 1-g portions at 157-160 °C for five minutes with stirring followed by vacuum sublimation. The yield of **2** in this step was not reported. In our hands, heating **1** neat at 157-160 °C produced **2** in less than 15% yield along with some **1** plus unidentified oligomeric products in large amounts.

Our initial attempts to improve the yield of **2** centered on acid-catalyzed cyclodehydration of **1** in an organic solvent. Thus, treatment of **1** with mineral acids such as hydrochloric acid, sulfuric acid, methanesulfonic acid, and phosphoric acid in alcohols, toluene, and chlorinated solvents at ambient or elevated temperatures produced only tarry materials. Attempt to remove the water as azeotrope by using Dean-Stark trap with refluxing toluene as solvent and p-toluenesulfonic acid as the catalyst also proved to be unsuccessful. Since the presence of acid can accelerate the cationic oligomerization of the desired product **2** into tarry materials, solvent-mediated thermal cyclodehydration of **1** was investigated as a possible solution to this problem.

After evaluating a number of common organic solvents, it was found that refluxing a solution of **1** in 2-ethoxyethyl acetate (bp 156 °C) for few hours produced **2** cleanly without the formation of by products in significant amounts. The reaction was monitored by thin layer chromatography and a simple aqueous work-up followed by flash chromatography yielded the desired **2** in 85-90% yield. Further purification by recrystallizing from n-hexane provided highly pure **2** in 78-84% yield from **1**.

In summary, a simple and high yield procedure to prepare the dibenzospiropyran (**2**) in multi-gram quantities has been developed. The solvent-mediated cyclization procedure described here should be adaptable to other substituted spirobenzopyran systems as well as their analogs such as the spirobi[naphthopyran] systems.

EXPERIMENTAL

Melting point was measured on a Thomas-Hoover apparatus and is uncorrected. The nmr spectrum was recorded on Varian XL-300 spectrometer. Flash chromatography was carried out on neutral alumina (BAKER, 80-200 mesh size) using the solvent system specified in the experiment.

2,2'-Spirobi[2H-1-benzopyran]. A solution of 1[5] (14 g, 0.052 mol) in 100 ml of 2-ethoxyethyl acetate was stirred and heated under reflux for 3 h. The reaction was monitored by thin layer chromatography on silica gel (ethyl acetate:hexane 1:2 v/v; R_f for 1 was 0.21 and that of product was 0.79). After cooling to room temperature, the solution was poured into 800 ml of water, stirred for 1 h, and the tan-colored crystals were collected by filtration and washed with water. The crude material was subjected to Flash chromatography on alumina and eluted with ethyl acetate:hexane (1:4 v/v) to provide colorless crystals (11.5 g, 88%), mp 100-102 °C. Recrystallization from n-hexane provided 10.4 g (81%) of the title compound as colorless crystals that melted at 101-102 °C (lit.,[5] mp 100-102 °C); ^{1}H nmr ($CDCl_3$) δ 5.91 (2H, d, J=9.9 Hz, hydrogens attached to the olefinic carbon next to the spiro-carbon), 6.71-7.30 (10H, m).

REFERENCES

* Dedicated to Prof. Edward C. Taylor on the occasion of his 70th birthday.

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