Organic Syntheses

A Publication
of Reliable Methods
for the Preparation
of Organic Compounds

Working with Hazardous Chemicals

The procedures in *Organic Syntheses* are intended for use only by persons with proper training in experimental organic chemistry. All hazardous materials should be handled using the standard procedures for work with chemicals described in references such as "Prudent Practices in the Laboratory" (The National Academies Press, Washington, D.C., 2011; the full text can be accessed free of charge at http://www.nap.edu/catalog.php?record_id=12654). All chemical waste should be disposed of in accordance with local regulations. For general guidelines for the management of chemical waste, see Chapter 8 of Prudent Practices.

In some articles in *Organic Syntheses*, chemical-specific hazards are highlighted in red "Caution Notes" within a procedure. It is important to recognize that the absence of a caution note does not imply that no significant hazards are associated with the chemicals involved in that procedure. Prior to performing a reaction, a thorough risk assessment should be carried out that includes a review of the potential hazards associated with each chemical and experimental operation on the scale that is planned for the procedure. Guidelines for carrying out a risk assessment and for analyzing the hazards associated with chemicals can be found in Chapter 4 of Prudent Practices.

The procedures described in *Organic Syntheses* are provided as published and are conducted at one's own risk. *Organic Syntheses, Inc.*, its Editors, and its Board of Directors do not warrant or guarantee the safety of individuals using these procedures and hereby disclaim any liability for any injuries or damages claimed to have resulted from or related in any way to the procedures herein.

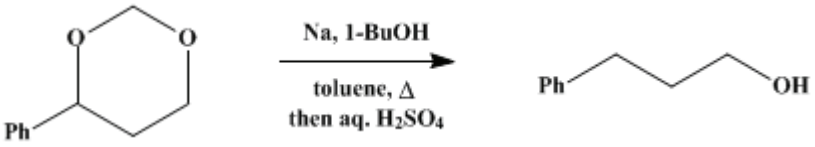
These paragraphs were added in September 2014. The statements above do not supersede any specific hazard caution notes and safety instructions included in the procedure.

DOI:10.15227/orgsyn.033.0076

Organic Syntheses, Coll. Vol. 4, p.798 (1963); Vol. 33, p.76 (1953).

3-PHENYL-1-PROPANOL

[1-Propanol, 3-phenyl-]



Submitted by R. L. Shriner and Philip R. Ruby[1].
Checked by Richard T. Arnold, W. E. Parham, and Hans Wynberg.

1. Procedure

In a 5-l. round-bottomed flask, equipped with two reflux condensers and a mechanical stirrer (Note 1), are placed 800 g. (925 ml.) of dry toluene and 168 g. (7.3 g. atoms) of sodium. The toluene is heated to boiling, the sodium is melted, and the stirrer is started. The source of external heat is removed, and a solution of 328 g. (2 moles) of 4-phenyl-*m*-dioxane (p. 786) in 311 g. (4.2 moles) of 1-butanol (Note 2) is added through the top of one of the condensers. The vapors should reflux about halfway up the condensers; about 30 to 60 minutes is used for the addition (Note 3). The mixture is cooled to room temperature, and a solution of 100 ml. of concentrated sulfuric acid in 800 ml. of water is added slowly with stirring. After the water layer is separated and discarded, 500 ml. of water is again added to the organic layer. Dilute sulfuric acid (5%) is added with shaking until the water layer is neutral to litmus paper. After the water layer is separated and discarded, the toluene and 1-butanol are removed from the organic layer by distillation. The remaining liquid is fractionated under reduced pressure (Note 4) to give 224–227 g. (82.2–83.4%) of 3-phenyl-1-propanol, b.p. 95–97°/0.4 mm. or 113–115°/3 mm., n_D^{20} 1.5268–1.5269, d_4^{20} 1.004–1.008.

2. Notes

1. The condenser should have a large bore to prevent flooding. A wide-sweep stirrer such as a Hershberg stirrer should be used, and the stirring motor must be capable of operating under heavy loads. The checkers suggest that the minimum size for the stirrer be 8-mm. glass rod.
2. The butanol should be freshly dried and distilled.
3. The addition must be as rapid as possible. An additional 100 to 400 ml. of toluene may have to be added to facilitate stirring.
4. A heated 35-cm. Vigreux column is recommended, but a Claisen flask can be used if care is taken. If a Claisen flask is used, the distillation must not be carried out too rapidly, particularly near the end, at which point some of the residue tends to codistil.

3. Discussion

Ethyl cinnamate has been reduced to 3-phenyl-1-propanol with sodium and ethanol,[2,3,4,5] hydrogen and copper chromite,[6] and sodium and ammonia.[7] The alcohol has also been prepared by reduction of the glyceride of cinnamic acid with sodium and amyl alcohol;[8] by reduction of cinnamic acid with lithium aluminum hydride;[9] by reduction of cinnamoyl chloride with sodium borohydride;[10] and by reduction of ethyl dihydrocinnamate with sodium and ethanol.[2,11] Cinnamaldehyde has been reduced to 3-phenyl-1-propanol with hydrogen and palladium.[12,13] platinum,[14,15,16] or nickel,[17,18,19,20] nickel in alkaline solution (no hydrogen),[21] lithium aluminum hydride,[22] electrolysis at a mercury[23] or lead[24] electrode, and with an unmentioned catalyst.[25] Reduction of cinnamyl alcohol to 3-phenyl-1-propanol has been effected by use of sodium and ethanol,[26] sodium amalgam and water,[27,28] hydrogen and nickel[29] or palladium,[30] sodium and ammonia,[31] and lithium aluminum hydride.[32] Other syntheses have been brought about by reduction of ethyl α,β-epoxy-β-phenyldihydrocinnamate with sodium and amyl alcohol;[33] by reduction of ethyl benzoylacetate with hydrogen and copper chromite;[34] by reduction of

acetonephenyllactic acid with hydrogen and copper chromite;[35] by reaction of ethyl alcohol with sodium benzylate;[36] by reaction of benzylmagnesium chloride with a mixture of ethylene chlorohydrin and ethylmagnesium chloride;[37] by reaction of trimethylene oxide with phenylmagnesium bromide;[38] by condensation of benzylmagnesium chloride with ethylene oxide;[39] and by hydrogenolysis of 1-phenyl-1,3-propanediol over nickel-on-kieselguhr.[40]

The reduction of 4-phenyl-*m*-dioxane to give 3-phenyl-1-propanol, as described here, is based on the procedure of Beets,[41] who used sodium and diisobutylcarbinol. Other substituted *m*-dioxanes may also be converted to substituted 3-aryl-1-propanols by the same procedure.[42] 3-Phenyl-1-propanol also has been obtained in 85% yield by the reduction of 4-phenyl-*m*-dioxane over copper chromite catalyst.[43]

References and Notes

1. State University of Iowa, Iowa City, Iowa.
2. Bouveault and Blanc, *Compt. rend.*, **137**, 328 (1903); *Bull. soc. chim. France*, [3] **31**, 1209 (1904).
3. Shorygin, Bogacheva, and Shepeleva, *Khim. Referat. Zhur.*, **1940**, 114 [*C. A.*, **36**, 3793 (1942)].
4. Clutterbuck and Cohen, *J. Chem. Soc.*, **123**, 2509 (1923).
5. Krushevskii and Gildburg, Russ. pat. 31,008 [*C. A.*, **28**, 3425 (1934)].
6. Adkins and Folkers, *J. Am. Chem. Soc.*, **53**, 1095 (1931); Wojcik and Adkins, *J. Am. Chem. Soc.*, **55**, 4939 (1933).
7. Chablay, *Compt. rend.*, **156**, 1022 (1913).
8. Darzens, *Compt. rend.*, **205**, 682 (1937).
9. Nystrom and Brown, *J. Am. Chem. Soc.*, **69**, 2548 (1947).
10. Chaikin and Brown, *J. Am. Chem. Soc.*, **71**, 122 (1949).
11. Burrows and Turner, *J. Chem. Soc.*, **119**, 428 (1921).
12. Straus and Grindel, *Ann.*, **439**, 307 (1924).
13. Endoh, *Rec. trav. chim.*, **44**, 869 (1925).
14. Skita, *Ber.*, **48**, 1692 (1915).
15. Tuley and Adams, *J. Am. Chem. Soc.*, **47**, 3063 (1925).
16. Vavon, *Compt. rend.*, **154**, 361 (1912); *Ann. chim. et phys.*, [9] **1**, 166 (1914).
17. Adkins and Billica, *J. Am. Chem. Soc.*, **70**, 695 (1948).
18. Braun and Kochendorfer, *Ber.*, **56**, 2175 (1923).
19. Delepine and Hanegraaff, *Bull. soc. chim. France*, [5] **4**, 2087 (1937).
20. Palfray, Sabetay, and Gauthier, *Compt. rend.*, **218**, 553 (1944).
21. Papa, Schwenk, and Whitman, *J. Org. Chem.*, **7**, 587 (1942).
22. Nystrom and Brown, *J. Am. Chem. Soc.*, **70**, 3738 (1948).
23. Shima, *Mem. Coll. Sci. Kyoto Imp. Univ.*, **A12**, 70 (1929).
24. Law, *J. Chem. Soc.*, **101**, 1030 (1912).
25. Walter, Ger. pat. 296,507 [*C. A.*, **13**, 368 (1919)].
26. Gray, *J. Chem. Soc.*, **127**, 1156 (1925).
27. Hatton and Hodgkinson, *J. Chem. Soc.*, **39**, 319 (1881).
28. Rugheimer, *Ann.*, **172**, 123 (1874).
29. Tanaka, *Chem. Ztg.*, **48**, 25 (1924).
30. Straus and Berkow, *Ann.*, **401**, 151 (1913).
31. Chablay, *Compt. rend.*, **143**, 829 (1906); *Ann. chim. et phys.*, [9] **8**, 191 (1914).
32. Hochstein and Brown, *J. Am. Chem. Soc.*, **70**, 3484 (1948).
33. Verley, *Bull. soc. chim. France*, [4] **35**, 488 (1924).
34. Adkins and Billica, *J. Am. Chem. Soc.*, **70**, 3121 (1948).
35. Oeda, *Bull. Chem. Soc. Japan*, **10**, 531 (1935).
36. Guerbet, *Compt. rend.*, **146**, 300 (1908); *Bull. soc. chim. France*, [4] **3**, 503 (1908).
37. Conant and Kirner, *J. Am. Chem. Soc.*, **46**, 241 (1924).
38. Searles, *J. Am. Chem. Soc.*, **73**, 124 (1951).
39. Ohara, Jap. pat. 4364 (1950) [*C. A.*, **47**, 3347 (1953)].
40. Arnold (to E. I. du Pont de Nemours & Co.), U. S. pat. 2,555,912 [*C. A.*, **46**, 3074 (1952)].

41. Beets, *Rec. trav. chim.*, **70**, 20 (1951).
42. Beets and Van Essen, *Rec. trav. chim.*, **70**, 25 (1951); Drukker and Beets, *Rec. trav. chim.*, **70**, 29 (1951).
43. Emerson, Heider, Longley, and Shafer, *J. Am. Chem. Soc.*, **72**, 5314 (1950).

Appendix
Chemical Abstracts Nomenclature (Collective Index Number); (Registry Number)

glyceride of cinnamic acid

ethyl dihydrocinnamate

ethyl α,β-epoxy-β-phenyldihydrocinnamate

acetonephenyllactic acid

ethyl alcohol,
ethanol (64-17-5)

sulfuric acid (7664-93-9)

ammonia (7664-41-7)

hydrogen (1333-74-0)

lead (7439-92-1)

mercury (7439-97-6)

platinum (7440-06-4)

butanol,
1-butanol (71-36-3)

nickel (7440-02-0)

toluene (108-88-3)

sodium (13966-32-0)

palladium (7440-05-3)

Ethylene oxide (75-21-8)

benzylmagnesium chloride (6921-34-2)

Phenylmagnesium bromide (100-58-3)

Ethyl cinnamate (103-36-6)

cinnamic acid (621-82-9)

ethylene chlorohydrin (107-07-3)

cinnamaldehyde

Trimethylene oxide (503-30-0)

amyl alcohol (71-41-0)

COPPER CHROMITE

Ethyl benzoylacetate (94-02-0)

cinnamyl alcohol (104-54-1)

lithium aluminum hydride (16853-85-3)

cinnamoyl chloride

3-Phenyl-1-propanol,
1-Propanol, 3-phenyl- (122-97-4)

sodium borohydride (16940-66-2)

sodium benzylate

ethylmagnesium chloride (2386-64-3)

1-phenyl-1,3-propanediol

diisobutylcarbinol (108-82-7)

4-Phenyl-m-dioxane (3141-24-0)