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.

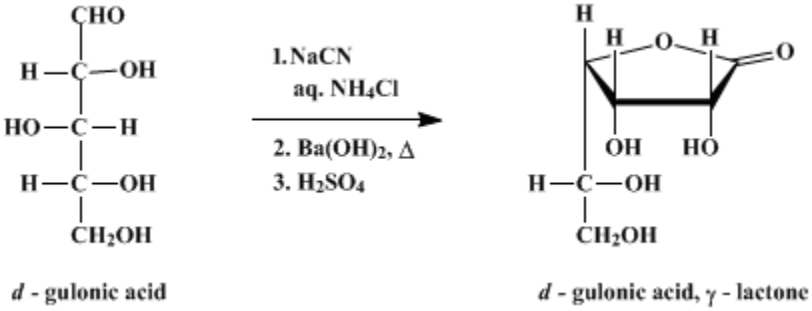
These paragraphs were added in September 2014. The statements above do not supersede any specific hazard caution notes and safety instructions included in the procedure.

DOI:10.15227/orgsyn.036.0038

Organic Syntheses, Coll. Vol. 4, p.506 (1963); Vol. 36, p.38 (1956).

D-GULONIC-γ-LACTONE

[D-Gulonic acid, γ-lactone]



d - gulonic acid — *d* - gulonic acid, γ - lactone

Submitted by J. V. Karabinos[1]
Checked by R. T. Arnold, Fred Smith, and Bertha Lewis.

1. Procedure

In a 500-ml. glass-stoppered Erlenmeyer flask, 30 g. (0.2 mole) of D-xylose and 10.7 g. (0.2 mole) of ammonium chloride are dissolved in 100 ml. of distilled water. Cracked ice (100 g.) is added to this mixture, followed by 10 g. (0.2 mole) of sodium cyanide, and the solution is maintained at 0–5° for 48 hours. Powdered barium hydroxide octahydrate (63 g., 0.2 mole) is added along with 100 ml. of water to the cyanohydrin mixture (Note 1), which is heated on a steam bath for 2 hours with occasional stirring. The basic barium gulonate (Note 2), which is allowed to separate overnight at 5°, is collected by filtration and washed with cold water (0°) until the washings are chloride-free. Excessive washing of the barium salt is to be avoided because of its solubility. The barium salt is suspended in 200 ml. of water, and the barium ion is precipitated quantitatively by sulfate ion (Note 3). After removal of the barium sulfate by suction filtration, the filtrate and washings are concentrated to a colorless syrup on a steam bath in a stream of dry air (Note 4). The resultant syrup is dissolved in 50 ml. of hot ethylene glycol monomethyl ether (methyl Cellosolve), sufficient ethyl acetate is added to incipient turbidity, and the solution is seeded with D-gulonic-γ-lactone (Note 5). The lactone, which is allowed to crystallize overnight, is collected by suction filtration, washed with ethanol and dried in a vacuum over at 60°. The D-gulonic-γ-lactone (Note 6) has a melting point of 181–183° which is unchanged by recrystallization from aqueous ethanol. The yield is 10.7–11.6 g. (30–33%) (Note 7).

2. Notes

1. The barium hydroxide serves to hydrolyze any unchanged nitriles as well as to precipitate the aldonic acid.
2. The barium gulonate is undoubtedly contaminated with some epimeric idonate. The lactone of the latter substance is removed by recrystallization of the gulonic lactone from methyl Cellosolve.
3. It is convenient to titrate the suspended barium salt with 18*N* sulfuric acid (approx. 12–14 ml.) to a pH of 1.5 using a pH meter. After removal of the barium sulfate the slight excess of sulfate ion may be precipitated using barium chloride solution. The end point is taken when several drops of filtrate show no turbidity either upon addition of sulfuric acid or barium chloride solution.
4. Concentration in this manner allows sufficient time for the gulonic acid to be converted to the lactone in the presence of a trace of hydrochloric acid. The checkers observed also that an easily crystallized lactone was always obtained if concentration under reduced pressure was employed.
5. Crystallization is speeded considerably by seeding.
6. A small amount of less pure lactone may be obtained by evaporation of the mother liquor to a syrup and repetition of the methyl Cellosolve-ethyl acetate crystallization.
7. The submitter has reported yields up to 39% using the above procedure.

3. Discussion

The present method is adapted from that of Fischer[2] employing recently developed modifications of the cyanohydrin synthesis.[3,4]

References and Notes

1. Blockson Chemical Company, Joliet, Illinois.
2. Fischer and Stahel, *Ber.*, **24**, 528 (1891).
3. Karabinos, Hann, and Hudson, *J. Am. Chem. Soc.*, **75**, 4320 (1953).
4. Isbell, Karabinos, Frush, Holt, Schwebel, and Galkowski, *J. Research Natl. Bur. Standards*, **48**, 163 (1952).

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

ethanol (64-17-5)

sulfuric acid (7664-93-9)

hydrochloric acid (7647-01-0)

ethyl acetate (141-78-6)

ammonium chloride (12125-02-9)

sodium cyanide (143-33-9)

barium chloride (10361-37-2)

barium sulfate (7727-43-7)

barium hydroxide (17194-00-2)

barium hydroxide octahydrate (12230-71-6)

methyl Cellosolve,
ethylene glycol monomethyl ether (109-86-4)

D-Gulonic-γ-lactone,
d-Gulonic acid, γ-lactone (6322-07-2)

d-xylose

barium gulonate

gulonic lactone

gulonic acid