

This article was downloaded by: [Universite Laval]

On: 08 October 2014, At: 18:31

Publisher: Taylor & Francis

Informa Ltd Registered in England and Wales Registered Number: 1072954

Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH, UK



Synthetic Communications: An International Journal for Rapid Communication of Synthetic Organic Chemistry

Publication details, including instructions for authors and subscription information:

<http://www.tandfonline.com/loi/lcyc20>

Catalytic Hydrogenation of L-Ascorbic Acid (Vitamin C): A Stereoselective Process for the Production of L-Gulono-1, 4-Lactone

David S. Soriano ^a, Chad A. Meserole ^a & Francis M. Mulcahy ^a

^a Department of Chemistry, University of Pittsburgh at Bradford, Bradford, PA, 16701

Published online: 23 Sep 2006.

To cite this article: David S. Soriano, Chad A. Meserole & Francis M. Mulcahy (1995) Catalytic Hydrogenation of L-Ascorbic Acid (Vitamin C): A Stereoselective Process for the Production of L-Gulono-1, 4-Lactone, *Synthetic Communications: An International Journal for Rapid Communication of Synthetic Organic Chemistry*, 25:20, 3263-3265, DOI: [10.1080/00397919508015478](https://doi.org/10.1080/00397919508015478)

To link to this article: <http://dx.doi.org/10.1080/00397919508015478>

PLEASE SCROLL DOWN FOR ARTICLE

Taylor & Francis makes every effort to ensure the accuracy of all the information (the "Content") contained in the publications on our platform. However, Taylor & Francis, our agents, and our licensors make no representations or warranties whatsoever as to the accuracy, completeness, or suitability for any purpose of the Content. Any opinions and views

expressed in this publication are the opinions and views of the authors, and are not the views of or endorsed by Taylor & Francis. The accuracy of the Content should not be relied upon and should be independently verified with primary sources of information. Taylor and Francis shall not be liable for any losses, actions, claims, proceedings, demands, costs, expenses, damages, and other liabilities whatsoever or howsoever caused arising directly or indirectly in connection with, in relation to or arising out of the use of the Content.

This article may be used for research, teaching, and private study purposes. Any substantial or systematic reproduction, redistribution, reselling, loan, sub-licensing, systematic supply, or distribution in any form to anyone is expressly forbidden. Terms & Conditions of access and use can be found at <http://www.tandfonline.com/page/terms-and-conditions>

**CATALYTIC HYDROGENATION OF L-ASCORBIC ACID (VITAMIN C):
A STEREOSELECTIVE PROCESS FOR THE PRODUCTION OF
L-GULONO-1, 4 - LACTONE**

David S. Soriano*, Chad A. Meserole, and Francis M. Mulcahy
Department of Chemistry, University of Pittsburgh at Bradford, Bradford, PA. 16701

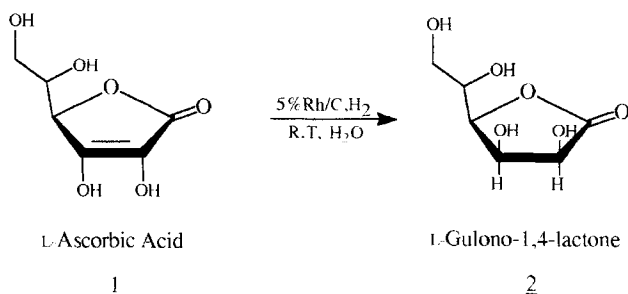
Introduction:

Reduction of functional groups with hydrogen gas is one of the most important reactions in organic chemistry, dating to the first hydrogenation of ethene to ethane reported by Von Wilde in 1874¹. Indeed, alkenes are generally rapidly hydrogenated, in the presence of a catalyst, usually, platinum, Raney nickel, palladium, or rhodium on carbon, to the corresponding alkane via heterogeneous reaction. Most undergraduate, introductory texts introduce this reaction as occurring via a stereospecific syn addition, although this is an oversimplification, due to possible rearrangements on the catalyst surface². While the chemistry of Vitamin C (L-ascorbic acid), in regards to oxidative degradation, is well studied, its behavior under reductive conditions has been relatively overlooked. The catalytic reduction of ascorbic acid has been reported earlier (24 hours, palladium catalyst, water, 50°) by workers at Pfizer³.

During our investigations into different conditions for the facile hydrogenation of 1, we have found Rhodium on Carbon (Caution: please refer to reference 3, in regards to the danger of activated Raney Nickel catalyst!) to be most effective catalyst and have found the process suitable for batch-quality production of the title compound. We have found, in agreement with prior work, that the hydrogenation proceeds with delivery of hydrogen from the least hindered side of the enono-lactone moiety opposite the side-chain of 1 to yield a

single stereoisomer L-gulono-1, 4-lactone 2. This process is, indeed, the exact reversal of the biochemical process found in organisms that bio-synthesize ascorbic acid where 2 is enzymatically dehydrogenated to 1 via the enzyme L-gulonolactone oxidase⁴.

There is currently a great deal of interest in 2 as a source of enantiomerically pure compounds for treatment of epilepsy, glaucoma, and hypertension⁵. As Ascorbic Acid is an item of commerce, this process represents an economic avenue for the production of relatively inexpensive drug candidates in the pharmaceutical industry and should serve as an interesting introduction to catalysis for the undergraduate chemistry major.



Experimental:

Commercially available L-ascorbic acid and 5% rhodium on carbon (Aldrich Chemical) were used as supplied. Reaction time and isolated yields (75-90%) are average and based on several trials. A Parr hydrogenator (catalog #3911, Parr Equipment Company, Moline IL.) was used for the hydrogenation studies. Optical activity measurements were conducted with an I²R polarimeter (I²R, Cheltenham, PA.).

A 500 ml Parr flask (tested to 1200 p.s.i.) was charged with 10.0 g L-ascorbic acid (176 g mol⁻¹, .057 mol) and 200 mL distilled water. To the homogeneous solution is added 1.0 g of 5% rhodium on carbon, followed by evacuation of the flask. The flask is then charged with sufficient hydrogen from the reserve tank to generate 55 p.s.i. pressure. The solution is shaken and the steady uptake of hydrogen noted. After about 90 minutes, uptake of hydrogen ceases, (corresponding to the uptake of one mol-equivalent of hydrogen) and the flask and reserve tank are carefully drained with water aspiration. The

contents of the flask is filtered, to remove the catalyst, and the filtrate added to a 250 ml round-bottomed flask, was concentrated by rotary-evaporation under vacuum. The water bath should be maintained at a temperature no higher than 45°C. The clear, residual syrup is added to a small beaker and the material allowed to crystallize overnight in the refrigerator. The white crystals are collected on a Buchner funnel and allowed to air-dry to constant weight. A typical trial yields 8.0 g of L-gulonolactone, m.p.: 187-190, lit.⁶:

187-190°C, F.T. i.r. (KBr) : 1780 cm, 300 MHZ. n.m.r. (D₂O) : 3.35-3.8 (m,3H), 4.15-4.45 (m,3H). $[\alpha]_{21}^D$ 52.8 (c = 0.17, H₂O)

Acknowledgments:

We would like to thank the University of Pittsburgh at Bradford for support through faculty development grants. This paper is dedicated to the memory of Dr. Linus Pauling.

Literature Cited:

- ¹ Smith, M.B.; Organic Synthesis: McGraw-Hill, NY. 1994, page 423.
- ² Mackie, R.K.; Smith, D.M.; Guidebook to Organic Synthesis; Longman Group Limited, Essex, England, 1983, page 174.
- ³ Andrews, G.C.; Crawford, T.C.; Bacon, B.E., J. Org. Chem. 1981, 46, pp. 2976- 2977.
We have found that complete reduction, with 10% palladium on carbon, proceeds in about 18 hours at ambient temperature. We evaluated the usual catalysts (Pt., Ru, Ni, etc.) and found minimal activity. CAUTION: in the case of activated Raney nickel (J. Org. Chem., Volume 26, 1961, page 1625) rapid decomposition of the ascorbic acid occurred, resulting in rapid pressure build-up leading to explosion of the Parr flask!
- ⁴ Dixon, M.; Webb, E.C., Enzymes; 3rd. Ed.; Academic Press, NY. 1979.
- ⁵ Hubschwerlen, C., Synthesis, 1986, pp 962-964.
- ⁶ Material has m.p. range identical to the L-gulono-1, 4-lactone of commerce. See: Aldrich Chemical catalog, 1994-1995, page 744.(cat. #31,030-1).

(Received in the USA 16 March 1995)