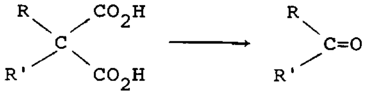
Tetrahedron Letters No.49, pp. 6145-6150, 1966. Pergamon Press Ltd.
Printed in Great Britain.

A NEW METHOD FOR THE OXIDATIVE DECARBOXYLATION OF DISUBSTITUTED MALONIC ACIDS USING LEAD TETRAACETATE

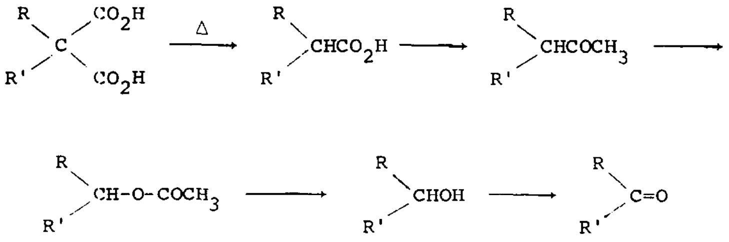
Joseph J. Tufariello and William J. Kissel
Department of Chemistry
State University of New York at Buffalo
Buffalo, New York 14214

(Received 4 September 1966)

The oxidative decarboxylation of disubstituted malonic acids (i.e., I → II) provides a useful extension of the malonic ester synthesis to include the preparation of ketones. Interestingly, we have been able to find relatively few useful methods capable of bringing about this interconversion (1). The method most commonly used is a rather lengthy five-step reaction sequence:



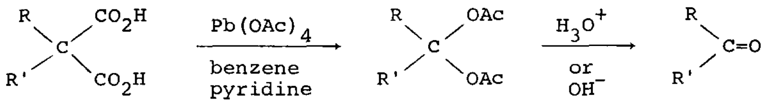
I II



Therefore, we chose to explore other approaches which might affect this transformation.

Lead tetraacetate is a reagent known to oxidatively decarboxylate aliphatic carboxylic acids to the corresponding alkyl acetates although in variable yield (2). Moreover, it has been demonstrated that 1,2-dicarboxylic acids are oxidatively decarboxylated to olefins by this reagent (3). Thus, we decided to investigate the reaction of lead tetraacetate with a variety of disubstituted malonic acids in order to determine whether these substances might be oxidatively decarboxylated to gem-diacetates, intermediates which would be readily converted into ketones under mild hydrolytic conditions.

The action of lead tetraacetate on malonic acids in refluxing benzene containing two equivalents of pyridine leads to decarboxylation, as evidenced by the precipitation of barium carbonate when the exit gases from the reaction are passed through a barium hydroxide solution. When carbon dioxide liberation ceases, the reaction mixture can be worked-up to give a neutral product possessing spectral characteristics anticipated for a *gem*-diacetate (*vide infra*). Hydrolysis of the diacetate under acidic or basic conditions leads to the formation of the corresponding ketone.



The products are easily purified by routine distillation and the yields are satisfactory (*i.e.*, 45-70%) in light of the simplicity of the two stage process. The results obtained from a number of disubstituted malonic acids are summarized in Table I.

TABLE I

Oxidative Decarboxylation of Malonic Acids Using Lead Tetraacetate[a]

Acid	Product	Yield(%)[b]
Di-*n*-butylmalonic	5-Nonanone	70
Phenylethylmalonic	Propiophenone	63
n-Butylethylmalonic	3-Heptanone	60
Ethyl-*i*-pentylmalonic	6-Methyl-3-heptanone	70
Cyclopentyl-1,1-dicarboxylic	Cyclopentanone	45
Cyclohexyl-1,1-dicarboxylic	Cyclohexanone	50

(a) Refer to the model experimental procedure for details of the method.

(b) These yields refer to distilled material and are based on the starting malonic acid.

We are currently investigating the lead tetraacetate induced oxidative decarboxylation of monosubstituted malonic acids as a means of generating aldehydes.

The model experimental procedure shown below was used for the oxidative decarboxylation of all of the malonic acids investigated.

EXPERIMENTAL PROCEDURE - Di-*n*-butylmalonic acid (6.31 g., 0.0292 mole) was dissolved in a solution of 40 ml. of benzene and 6 ml. (*ca.*, 0.07 mole) of pyridine. The lead tetraacetate (29.8 g., 0.0642 mole), which had been vacuum dried over potassium hydroxide pellets, was added and the reaction mixture gently warmed until the evolution of carbon dioxide commenced. At this point, the source of heat was removed and was reapplied only after the initial carbon dioxide evolution had ceased. The mixture was then brought to reflux with continuous stirring for three hours.

After the addition of 100 ml. of ether to the cooled reaction mixture, the solution was filtered and the salts washed with additional ether. The combined ether solutions were washed with two 50 ml. portions of cold 2*N* hydrochloric acid, two 50 ml. portions of cold saturated sodium bicarbonate, and a cold brine solution. The ether solution was dried over anhydrous magnesium sulfate and the ether removed by distillation.

The residual liquid was hydrolyzed for 30 minutes on a steam bath in a solution containing 7 g. of potassium hydroxide, 15 ml. of water and 15 ml. of methanol. Ether

(100 ml.) was added to the cool hydrolysis mixture and the aqueous layer was saturated with potassium carbonate. The layers were separated and the aqueous phase was washed with four 50 ml. portions of ether. The combined organic extracts were dried over magnesium sulfate, the ether removed evaporatively, and the product distilled to give 2.97 g. (70%) of 5-nonanone.

In certain cases, the crude *gem*-diacetate, obtained after removal of the ether but prior to the hydrolysis, was examined spectrally. In general, these materials showed a sharp singlet in the n.m.r. spectrum at 1.9-2.0 p.p.m. from TMS (acetate methyls) and broad, intense absorption at *ca.* 5.68 μ (ester carbonyls) in the infra-red. Attempted vapor phase chromatographic examination or distillation of the *gem*-diacetate led to partial decomposition into the corresponding ketone and acetic anhydride.

ACKNOWLEDGMENTS

We wish to thank Professor Jerrold Meinwald for many helpful discussions during the early stages of this work. This research was supported in part by the National Science Foundation (GP-3525).

REFERENCES

1. J. Meinwald, J. J. Tufariello, and J. J. Hurst, J. Org. Chem., **29**, 2914 (1964), and references therein.
2. W. A. Mosher and C. L. Kerr, J. Am. Chem. Soc., **75**, 3172 (1953); M. S. Kharasch, H. N. Friedlander, and W. Urry, J. Org. Chem., **16**, 533, (1951); D. Benson, L. H. Sutcliffe, and J. Walkely, J. Am. Chem. Soc., **81**, 4488, (1959); E. J. Corey and J. Casanova, ibid., **85**, 165, (1963); W. H. Starnes Jr., ibid., **86**, 5603, (1964); J. K. Kochi, ibid., **87**, 1811, 3609 (1965).
3. C. A. Grob, E. Renk, and A. Weiss, Helv. Chim. Acta., **41**, 1191 (1958); C. A. Grob and A. Weiss, ibid., **43**, 1390 (1960); N. B. Chapman, Chem. Commun., 214 (1965).