



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](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.

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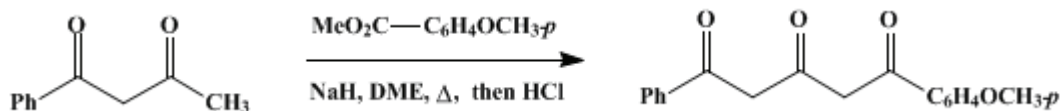
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*These paragraphs were added in September 2014. The statements above do not supersede any specific hazard caution notes and safety instructions included in the procedure.*

*Organic Syntheses, Coll. Vol. 5, p.718 (1973); Vol. 46, p.57 (1966).*

## 1-(*p*-METHOXYPHENYL)-5-PHENYL-1,3,5-PENTANETRIONE

### [1,3,5-Pentanetrione, 1(*p*-methoxyphenyl)-5-phenyl-]



Submitted by Marion L. Miles, Thomas M. Harris, and Charles R. Hauser<sup>1</sup>.  
Checked by Victor Nelson, Wayland E. Noland, and William E. Parham.

## 1. Procedure

*Caution! Sodium hydride causes severe burns if brought into contact with the skin and, in the dry state, is pyrophoric. Since hydrogen is evolved during the course of the reaction, the necessary precautions against fire and explosion should be taken.*

A 1-l. three-necked flask is fitted with a sealed mechanical stirrer, an addition funnel with a pressure-equalizing side arm, and a reflux condenser with a gas take-off at the upper end. The gas take-off is connected by means of rubber tubing to one arm of a glass Y-tube. The other arm of the Y-tube is connected to a source of dry nitrogen gas. The bottom of the Y-tube is immersed just beneath the surface of a little 1,2-dimethoxyethane (monoglyme) contained in a small beaker.

The flask is swept with a stream of dry nitrogen. Monoglyme (100 ml.) (Note 1) and sodium hydride (6 g., 0.25 mole) (Note 2) are placed in the flask. A solution of 8.1 g. (0.050 mole) of benzoylacetone (Note 3) and 12.5 g. (0.075 mole) of methyl anisate (Note 4) in 100 ml. of monoglyme is placed in the addition funnel. The funnel is stoppered, and the nitrogen flow rate is adjusted so that approximately 10 bubbles per minute are emitted from the bottom of the Y-tube. The sodium hydride slurry is stirred and heated on the steam bath. When reflux is obtained, the solution of benzoylacetone and methyl anisate is added slowly so that hydrogen evolution is maintained at a controllable rate. The reaction mixture is kept at the reflux temperature for 6 hours.

The reaction mixture is then cooled to room temperature, the reflux condenser is replaced with a distillation condenser equipped with a vacuum take-off, and most of the solvent is removed under reduced pressure (*ca.* 100 mm.) until a thick paste is obtained. The mixture is then cooled in an ice water bath, and 150 ml. of ether is added. Cold water (200 ml.) is placed in the addition funnel, and initially the water is added dropwise (*Caution! Vigorous evolution of hydrogen*) until the excess sodium hydride is destroyed; then the remainder of the water is added more rapidly (Note 5).

The reaction mixture is poured into a 1-l. separatory funnel, and the aqueous layer is removed. The ether layer is extracted with two 100-ml. portions of water and then with 100 ml. of aqueous 1% sodium hydroxide. The extracts are combined with the original aqueous layer, and the resulting solution is washed once with 100 ml. of fresh ether. Crushed ice (100 g.) is added to the solution, followed by 30 ml. of 12*N* hydrochloric acid. The product, which precipitates at this point, is removed by filtration, washed with water, and recrystallized from 450 ml. (Note 6) of 95% ethanol. The yield of 1-(*p*-methoxyphenyl)-5-phenyl-1,3,5-pentanetrione is 11.4–12.8 g. (77–86%) (Note 7), m.p. 120–121.5°.

## 2. Notes

1. Eastman Kodak (Eastman grade) 1,2-dimethoxyethane was dried for 24 hours over calcium hydride, distilled from sodium metal, and then stored over calcium hydride.
2. The submitters used sodium hydride obtained as a 50% dispersion in mineral oil from Ventron Corp. This material was used as received.
3. The benzoylacetone was obtained from Eastman Kodak (Eastman grade), m.p. 57–58°.

4. Eastman Kodak (Eastman grade) [methyl anisate](#) was used without further purification.
5. The checkers observed that the thick brown oil, which separates as the water is added, may partially solidify when stored overnight. The solid was melted on a steam bath, placed in the separatory funnel, and processed with the rest of the reaction mixture as described.
6. The checkers used 480 ml. of 95% [ethanol](#).
7. The checkers found that the product retained as much as 2 g. of [ethanol](#) after 20 minutes of air drying. The product was dried to constant weight.

### 3. Discussion

The method described is that of Miles, Harris, and Hauser<sup>2</sup> and is an improvement over the earlier procedure of Hauser and co-workers.<sup>3,4</sup> In the earlier method the dianion of [benzoylacetone](#), formed by the action of alkali amide in liquid [ammonia](#), was treated with [methyl anisate](#) to yield [1-\(\*p\*-methoxyphenyl\)-5-phenyl-1,3,5-pentanetrione](#) (61% based on the ester). This compound has also been prepared by the base-catalyzed ring opening of [2-\(\*p\*-methoxyphenyl\)-6-phenyl-4-pyrone](#); however, no yield is reported.<sup>5</sup>

### 4. Merits of the Preparation

This procedure appears to be fairly general for the aroylation of  $\beta$ -diketones to give 1,3,5-triketones. Using this method, the submitters<sup>2</sup> have aroylated [benzoylacetone](#) with [methyl benzoate](#) (87%), [methyl \*p\*-chlorobenzoate](#) (78%), and [ethyl nicotinate](#) (69%). Also, [acetylacetone](#) has been monobenzoylated with [methyl benzoate](#) to form [1-phenyl-1,3,5-hexanetrione](#) in 75% yield or dibenzoylated with the same ester to form [1,7-diphenyl-1,3,5,7-heptanetetraone](#) in 56% yield.<sup>6</sup> Symmetrical 1,5-diaryl-1,3,5-pentanetriones can be conveniently prepared by a similar procedure<sup>2</sup> from [acetone](#) and two equivalents of the appropriate aromatic ester; for example, [1,5-diphenyl-1,3,5-pentanetrione](#) and [1,5-di\(\*p\*-methoxyphenyl\)-1,3,5-pentanetrione](#) are formed in yields of 82% and 77%, respectively.

1,3,5-Triketones are useful intermediates in the preparation of 4-pyrones, 4-pyridones,<sup>3,4</sup> and other cyclic products.

This preparation is referenced from:

- [Org. Syn. Coll. Vol. 5, 721](#)

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### References and Notes

1. Chemistry Department, Duke University, Durham, North Carolina. This research was supported by the National Science Foundation.
2. M. L. Miles, T. M. Harris, and C. R. Hauser, *J. Org. Chem.*, **30**, 1007 (1965).
3. C. R. Hauser and T. M. Harris, *J. Am. Chem. Soc.*, **80**, 6360 (1958).
4. R. J. Light and C. R. Hauser, *J. Org. Chem.*, **25**, 538 (1960).
5. G. Soliman and I. E. El-Kholy, *J. Chem. Soc.*, 1755 (1954).
6. M. L. Miles, T. M. Harris, and C. R. Hauser, *J. Am. Chem. Soc.*, **85**, 3884 (1963).

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### Appendix

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

1,2-dimethoxyethane (monoglyme)

Monoglyme

ethanol (64-17-5)  
hydrochloric acid (7647-01-0)  
ammonia (7664-41-7)  
ether (60-29-7)  
hydrogen (1333-74-0)  
sodium hydroxide (1310-73-2)  
nitrogen (7727-37-9)  
acetone (67-64-1)  
sodium (13966-32-0)  
methyl benzoate (93-58-3)  
Acetylacetone (123-54-6)  
benzoylacetone (93-91-4)  
sodium hydride (7646-69-7)  
calcium hydride (7789-78-8)  
1,2-dimethoxyethane (110-71-4)  
methyl anisate (121-98-2)  
ethyl nicotinate (614-18-6)  
1-phenyl-1,3,5-hexanetrione  
1,7-diphenyl-1,3,5,7-heptanetetraone  
1,5-diphenyl-1,3,5-pentanetrione (1467-40-9)  
1-(p-Methoxyphenyl)-5-phenyl-1,3,5-pentanetrione,  
1,3,5-Pentanetrione, 1-(p-methoxyphenyl)-5-phenyl- (1678-17-7)  
2-(p-Methoxyphenyl)-6-phenyl-4-pyrone (14116-43-9)  
methyl p-chlorobenzoate (1126-46-1)  
1,5-di(p-methoxyphenyl)-1,3,5-pentanetrione