



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.

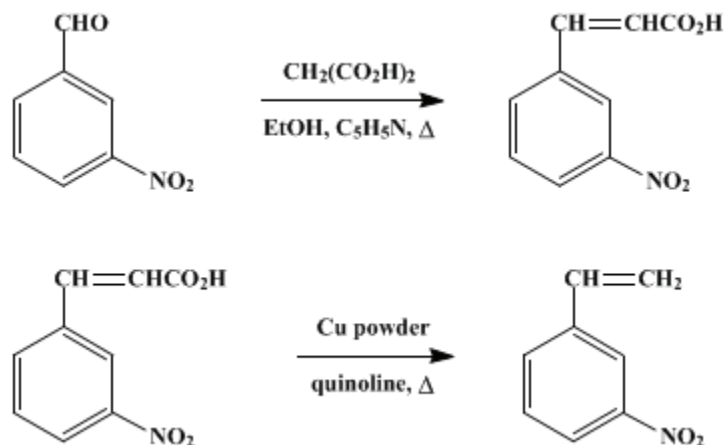
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These paragraphs were added in September 2014. The statements above do not supersede any specific hazard caution notes and safety instructions included in the procedure.

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m-NITROSTYRENE

[Styrene, *m*-nitro-]



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Checked by Richard T. Arnold, William E. Parham, and Darwin D. Davis.

1. Procedure

A. *m*-Nitrocinnamic acid. In a 1-l. round-bottomed flask fitted with a reflux condenser are placed 151 g. (1 mole) of *m*-nitrobenzaldehyde (Note 1), 115 g. (1.1 moles) of malonic acid, 250 ml. of 95% ethanol, and 25 ml. of pyridine. The mixture is heated on a steam bath under gentle reflux for 6–8 hours and cooled. The large masses of crystals are broken up with a spatula, and the reaction mixture is cooled in an ice bath. The solid is collected on a Büchner funnel, and the residue is washed with 100 ml. of cold ethanol and then with two 100-ml. portions of ether. The crude *m*-nitrocinnamic acid is suspended in 300 ml. of ethanol and digested on a steam plate for 2–3 hours. The mixture is cooled and filtered, and the solid is air-dried. The product, 144–155 g. (75–80%), is a light-yellow solid and melts at 200–201° (Note 2).

B. *m*-Nitrostyrene. In a 250-ml. two-necked flask equipped with a 250° thermometer and an air condenser are placed 30 g. (0.155 mole) of *m*-nitrocinnamic acid, 2 g. of copper powder, and 60 ml. of dry quinoline (Note 3). The flask is heated with a Bunsen burner to 185–195°, during which time a steady stream of carbon dioxide is evolved. After 2–3 hours (Note 4), the reaction mixture is cooled and poured into a mixture of 75 ml. of concentrated hydrochloric acid and 175 g. of ice. The *m*-nitrostyrene is isolated by steam distillation, approximately 1 l. of distillate being collected. The aqueous distillate is extracted with three 50-ml. portions of chloroform, which are combined and dried over anhydrous sodium sulfate. A 50-ml. Claisen flask, equipped with a dropping funnel, is heated on a steam bath, and the filtered chloroform extract is added dropwise. Heating is continued until all the solvent has been removed. The residue is then distilled at 3–5 mm. pressure. Following a small fore-run of less than 1 g. (Note 5), the *m*-nitrostyrene distils as a yellow liquid. The yield is 13–14 g. (56–60%), b.p. 90–96°/3.5 mm., n_D^{20} 1.5836, n_D^{27} 1.5800–1.5802 (Note 6) and (Note 7).

2. Notes

- The checkers used technical *m*-nitrobenzaldehyde melting at 53–56°.
- This procedure has been used by the submitters and others to prepare the following cinnamic acids from substituted benzaldehydes: *o*-nitrocinnamic acid (70%),² *p*-nitrocinnamic acid (77%),² *m*-cyanocinnamic acid (71%),³ *o*-chlorocinnamic acid (82%),⁴ *m*-chlorocinnamic acid (53%),⁴ *p*-chlorocinnamic acid (73%),⁴ 2,4-dichlorocinnamic acid (70%),⁴ 3,4-dichlorocinnamic acid (81%),⁴ *m*-bromocinnamic acid (31%),⁴ *p*-methoxycinnamic acid (60%),⁴ and 3,4-dimethoxycinnamic acid (77%).⁴

The method constitutes a simple preparation of ethanol-insoluble cinnamic acids, of a high degree of purity when compared with the Perkin reaction⁵ or the usual procedure for the Doebner reaction (p. 327), which uses a large excess of pyridine. A useful modification of this reaction is to warm the reactants on a steam plate in the absence of alcohol.^{6,7}

3. Quinoline that has been purified by steam distillation of an acid solution should be used. Crude quinoline sometimes contains non-basic, high-boiling impurities such as nitrobenzene, which make the purification of *m*-nitrostyrene more difficult.

4. The checkers obtained a lower yield (9–11 g.) when a 2-hour heating period was used. The reaction must be carried out at 195° until the evolution of carbon dioxide has practically ceased (usually 2.75 hours). The checkers used Mallinckrodt copper powder.

5. The checkers obtained essentially no fore-run and only trace amounts of solid residue. The refractive index of the first 200 mg. was n_D^{27} 1.5800; of the center fractions, n_D^{27} 1.5802; and of the last 700 mg., n_D^{27} 1.5800.

6. This procedure has been used in the preparation of other nitrostyrenes in the following yields: *o*-nitrostyrene (40%),² *p*-nitrostyrene (41%),² and 3-nitro-4-hydroxystyrene (60%).² A better procedure for more volatile styrenes involves simultaneous decarboxylation and codistillation with quinoline from the reaction flask. This method has been used to prepare the following styrenes: *o*-chlorostyrene (50%),⁴ *m*-chlorostyrene (65%),⁴ *p*-chlorostyrene (51%),⁴ *m*-bromostyrene (47%),⁴ *o*-methoxystyrene (40%),⁴ *p*-methoxystyrene (76%),⁴ *m*-cyanostyrene (51%),³ and *p*-formylstyrene (52%).⁸

7. Larger runs usually give smaller percentage yields.

3. Discussion

m-Nitrocinnamic acid has been prepared from *m*-nitrobenzaldehyde with sodium acetate and acetic anhydride,⁵ and by the condensation of *m*-nitrobenzaldehyde with malonic acid in the presence of bases.^{7,9}

m-Nitrostyrene has been prepared by boiling the sodium salt of β -bromo- β -(*m*-nitrophenyl) propionic acid;¹⁰ by the dehydration of *m*-nitrophenylmethylcarbinol with phosphorus pentoxide,¹¹ potassium bisulfate,¹² or phosphoric acid¹³; by the decarboxylation of *m*-nitrocinnamic acid;¹⁴ and by the condensation of *m*-nitrobenzaldehyde with acetic anhydride over bentonite at high temperatures.¹⁵

References and Notes

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

bentonite

ethanol (64-17-5)

hydrochloric acid (7647-01-0)

ether (60-29-7)

acetic anhydride (108-24-7)

sodium acetate (127-09-3)

chloroform (67-66-3)

sodium sulfate (7757-82-6)

carbon dioxide (124-38-9)

potassium bisulfate (7646-93-7)

copper powder (7440-50-8)

pyridine (110-86-1)

phosphoric acid (7664-38-2)

Nitrobenzene (98-95-3)

Quinoline (91-22-5)

Malonic acid (141-82-2)

2,4-dichlorocinnamic acid

3,4-dichlorocinnamic acid

3,4-dimethoxycinnamic acid

3-nitro-4-hydroxystyrene

phosphorus pentoxide (1314-56-3)

m-Nitrobenzaldehyde (99-61-6)

m-Nitrocinnamic acid (555-68-0)

p-nitrocinnamic acid (619-89-6)

m-Chlorostyrene (2039-85-2)

o-Chlorostyrene (2039-87-4)

p-Chlorostyrene (1073-67-2)

m-Bromostyrene (2039-86-3)

o-nitrocinnamic acid

m-Nitrostyrene,
Styrene, m-nitro- (586-39-0)

m-cyanocinnamic acid

o-chlorocinnamic acid (3752-25-8)

m-chlorocinnamic acid (1866-38-2)

p-chlorocinnamic acid (1615-02-7)

m-bromocinnamic acid (32862-97-8)

p-methoxycinnamic acid

o-nitrostyrene

p-nitrostyrene (100-13-0)

o-methoxystyrene (612-15-7)

p-methoxystyrene (637-69-4)

m-cyanostyrene

p-formylstyrene (1791-26-0)

m-nitrophenylmethylcarbinol (52022-77-2)

sodium salt of β -bromo- β -(m-nitrophenyl) propionic acid