



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.

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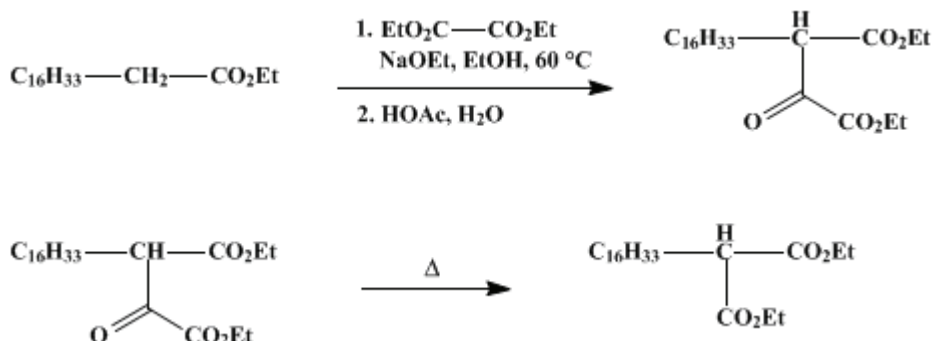
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These paragraphs were added in September 2014. The statements above do not supersede any specific hazard caution notes and safety instructions included in the procedure.

Organic Syntheses, Coll. Vol. 4, p.141 (1963); Vol. 34, p.13 (1954).

CETYLMALONIC ESTER

[Malonic acid, cetyl-, diethyl ester]



Submitted by Don E. Floyd and Sidney E. Miller¹.
Checked by James Cason and George A. Gillies.

1. Procedure

A solution of sodium ethoxide in ethanol is prepared by adding 23 g. (1 g. atom) of freshly cut sodium metal, as $\frac{1}{4}$ -in. cubes, in portions of 3–4 g., to 300 ml. of absolute ethanol, contained in a 1-l. three-necked flask, fitted with a thermometer and an upright, water-cooled condenser, the open end of which is capped with a drying tube filled with a mixture of Drierite and coarse lime (Note 1). The sodium is added through the third neck of the flask, which is otherwise kept stoppered.

When all the sodium has dissolved, the condenser is removed and 584 g. (4 moles) of diethyl oxalate (Note 2) and 312 g. (1 mole) of ethyl stearate (Note 3) are quickly added. The condenser is replaced by a still head connected to a condenser and receiver arranged for distillation at reduced pressure. If a water aspirator is used, a drying tube filled with Drierite should be inserted in the line between the receiver and aspirator. The receiver is cooled in a bath of ice water. The reaction mixture is heated at 50°, and the pressure in the system is reduced to about 100 mm. The temperature is gradually raised to 60°, with the system at a pressure of 100 ± 10 mm., to remove the ethanol used as solvent and formed as by-product. This distillation requires 2–3 hours (Note 4).

The receiver is changed and the excess diethyl oxalate is distilled under reduced pressure in the range of 76–82°/15 mm. (Note 5). The residue in the reaction flask, a viscous, red-brown mass, consists of the sodio derivative of ethyl α -ethoxalylstearate (Note 6). To it is gradually added, without cooling, 66 g. (1.1 mole) of glacial acetic acid. As the mixture is stirred by hand, 1 l. of water is added. Finally, the mixture is stirred mechanically for a few minutes, then allowed to separate into layers. The organic (upper) layer is taken up in 300 ml. of ether and washed well with sodium bicarbonate solution and with water; then the ether is removed by distillation from a steam bath.

The residual α -ethoxalyl ester is decarboxylated to cetylmalonic ester by heating at 160–170° under reduced pressure. A water aspirator is sufficient to facilitate removal of the carbon monoxide formed during the heating. The decarboxylation requires about 1–1.5 hours (Note 7). The cetylmalonic ester which remains as a dark liquid is fractionated under reduced pressure (Note 8).

A fore-run, consisting of ethyl stearate and an intermediate fraction, amounts to about 60 g., b.p. 185–204°/2 mm. (Note 8). The product is a colorless liquid amounting to 265–275 g. (68.5–71% yield), b.p. 204–208°/2 mm., n_D^{25} 1.4433 (Note 9) and (Note 10).

2. Notes

1. The evolved hydrogen should be led into a hood or out of a window to minimize the explosion

hazard.

2. **Diethyl oxalate** can be dried satisfactorily by distilling a small portion from the bulk of the material. The water is removed with the distillate.
3. The **ethyl stearate** used by the checkers was prepared by esterifying commercial **stearic acid** (Armour Neo-Fat 1-65 or General Mills Aliphatic 7) with 8 equivalents of absolute **ethanol** containing 10% by weight of concentrated **sulfuric acid**. The washed and dried product was distilled directly through a 60-cm. Vigreux column with a heated jacket and partial reflux head to give an 80% yield of material, b.p. 186.5-189°/3.5 mm., m.p. 32.2-34.2° (cor.). The purest grade of **ethyl stearate** as supplied by the Eastman Kodak Company is also satisfactory.
4. A column is not needed during distillation of the **ethanol**. When low-molecular-weight esters are substituted for **ethyl stearate** a suitable indented column should be used at this point to prevent loss of the ester. The reaction temperature should not be allowed to exceed 60°, because decomposition of the condensation product may result.
5. The contents of the flask should not be heated to a temperature higher than 90° during removal of the excess oxalate or some decomposition of the product may result. The recovered **diethyl oxalate** contains small amounts of **ethanol** and **ethyl carbonate**. It can readily be purified by fractional distillation; however, it is quite suitable for reuse in repeat preparations without purification.
6. This sodio derivative can be dissolved in a solvent such as **toluene** and employed as an intermediate for other reactions (alkylation, acylation, etc.).
7. The **carbon monoxide** evolved should be led into a hood to avoid the dangers of poisoning and explosion. No difficulties have been encountered at this stage, but precautions are advisable.
8. A 60-cm. column of the Vigreux type, with heated jacket and partial reflux head, was found satisfactory by the checkers. **Ethyl stearate** may solidify in the condenser if a total reflux head is used. Refractionation of the fore-run gives an additional 30-40 g. (10-13%) of pure product. Material containing a few per cent of **ethyl stearate** can be obtained in 85-90% yield by simply distilling the total crude product from a Claisen flask.
9. **Cetylmalonic acid**, m.p. 115.5-120.5°, is obtained by saponification of the ester and one crystallization from **acetone**.
10. This general procedure is applicable to lower fatty acid esters.

3. Discussion

This method is based on the general procedure previously described by Floyd and Miller.² Cetylmalonic ester has also been prepared by condensation of **ethyl stearate** with **ethyl carbonate**³ and by alkylation of sodiomalonic ester with **cetyl iodide**⁴ or **cetyl bromide**.⁵

References and Notes

1. General Mills Laboratory, Minneapolis, Minnesota.
2. Floyd and Miller, *J. Am. Chem. Soc.*, **69**, 2354 (1947).
3. Wallingford, Homeyer, and Jones, *J. Am. Chem. Soc.*, **63**, 2056 (1941).
4. Kraft, *Ber.*, **17**, 1630 (1884); Guthzeit, *Ann.*, **206**, 357 (1881).
5. Phillips and Mumford, *J. Chem. Soc.*, **1931**, 1736.

Appendix

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

sodiummalonic ester

Cetylmalonic ester

sodio derivative of ethyl α -ethoxalylstearate

ethanol (64-17-5)

sulfuric acid (7664-93-9)

acetic acid (64-19-7)

ether (60-29-7)

hydrogen (1333-74-0)

carbon monoxide (630-08-0)

sodium bicarbonate (144-55-8)

acetone (67-64-1)

toluene (108-88-3)

sodium (13966-32-0)

sodium ethoxide (141-52-6)

ethyl carbonate

cetyl iodide (544-77-4)

stearic acid (57-11-4)

Malonic acid, cetyl-, diethyl ester (41433-81-2)

diethyl oxalate (95-92-1)

ethyl stearate (111-61-5)

Cetylmalonic acid (4371-64-6)

cetyl bromide (112-82-3)