A Publication
of Reliable Methods
for the Preparation
of Organic Compounds

Working with Hazardous Chemicals

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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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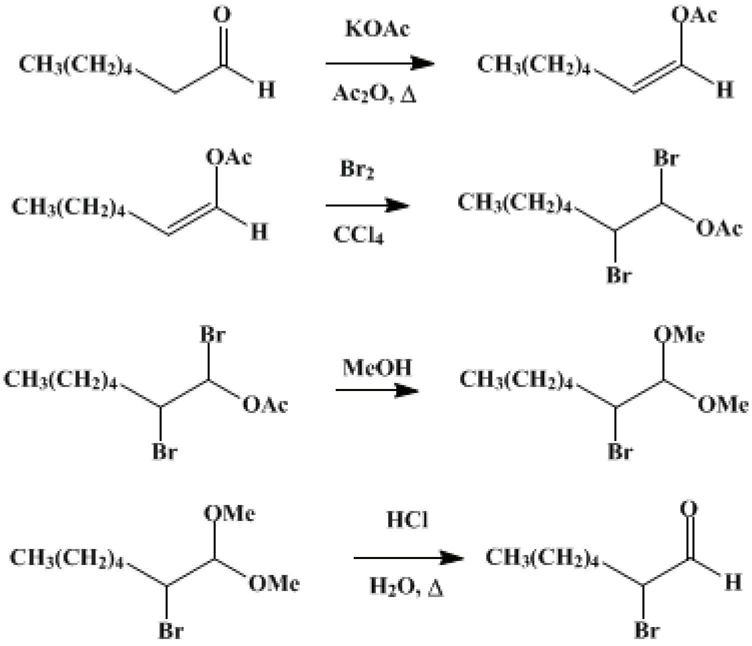
α-BROMOHEPTALDEHYDE

[Enanthaldehyde, α-bromo-]



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1. Procedure

Caution! Since most of the reactants are of unpleasant odor or have lachrymatory effects it is best to use a good hood.

A. *Heptaldehyde enol acetate.* A mixture of 285 g. (335 ml., 2.5 moles) of heptaldehyde (Note 1), 612 g. (566 ml., 6 moles) of acetic anhydride, and 49 g. (0.5 mole) of powdered potassium acetate is placed in a 2-l. flask fitted with a reflux condenser. The flask is heated in an oil bath kept at 155–160° for 1 hour. The mixture is then allowed to cool, placed in a 2-l. separatory funnel, washed several times with warm water (Note 2) to remove the excess acetic anhydride, and finally washed with 5% sodium carbonate solution (Note 3). The resultant oil is fractionated under reduced pressure through an efficient column (Note 4). The initial fraction consists of pure heptaldehyde followed by heptaldehyde containing heptaldehyde enol acetate. The fraction boiling at 88–90°/17 mm. is pure enol acetate, n_D^{25} 1.4295–1.4305; d_4^{25} 0.880–0.884. The yield is 175–195 g. (45–50%) (Note 5).

B. α-*Bromoheptaldehyde dimethyl acetal.* A solution of 156 g. (177 ml., 1 mole) of the enol acetate and 200 ml. of carbon tetrachloride is placed in a 1-l. flask and cooled in an ice-water bath. A mixture of 160 g. (51 ml., 1 mole) of bromine and 50 ml. of carbon tetrachloride is added slowly through a buret, the flask being constantly shaken and the rate of addition so controlled as not to allow the temperature of the brominated mixture to rise above 10° (Note 6). The addition of bromine takes from 20 minutes to 1 hour, and the end point is reached when the calculated amount is absorbed and the bromine is no longer decolorized. The brominated mixture is added to 600 ml. of anhydrous methanol (Note 7) and allowed to stand for 48 hours or longer. At the end of this period the mixture is diluted with 2 l. of water and the separated oil (lower layer) is washed with 1 l. of water and finally with 1 l. of 5% sodium carbonate (Note 8). The carbon tetrachloride and methyl acetate are removed by distillation at atmospheric pressure. The residual oil is then distilled under reduced pressure in the presence of a small amount of sodium carbonate. The fraction boiling at 117–119°/17 mm. is collected as pure α-bromoheptaldehyde dimethyl acetal, n_D^{25} 1.4510–1.4520; d_4^{25} 1.180–1.195. The yield is 191–203 g. (80–85%) (Note 9).

C. α-*Bromoheptaldehyde*. A mixture of 119.5 g. (100 ml., 0.5 mole) of α-bromoheptaldehyde dimethyl acetal and 80 ml. of concentrated hydrochloric acid is boiled gently in a 250-ml. distilling flask, and the methanol liberated is removed by distillation, which is continued slowly until the vapor temperature reaches 90°, at which point the heating is stopped and the residue and distillate are combined and diluted with 200 ml. of water. The somewhat brownish oil which separates is distilled under reduced pressure from a 250-ml. Claisen flask. The yield of pure α-bromoheptaldehyde, boiling at 87–92°/17 mm., n_D^{25} 1.4580–1.4600, d_4^{25} 1.210–1.230, is 87–92.5 g. (90–95%).

2. Notes

1. The heptaldehyde should be a freshly distilled product boiling at 151.5–153.5°.
2. Decomposition of the excess acetic anhydride takes place very slowly and with difficulty unless warm water is used. The checkers used three portions of wash water at 40–50°, totaling 1.3 l.
3. The checkers found that five or six portions of 5% sodium carbonate totaling 5 l. were required before rapid carbon dioxide evolution ceased.
4. The reaction mixture consists of unchanged heptaldehyde, heptaldehyde enol acetate, heptaldehyde diacetate, and a small amount of polymerized material. The proportion of free heptaldehyde and heptaldehyde diacetate depends upon the time of heating, longer periods of heating favoring the formation of the diacetate. An efficient fractionating column, preferably of the Whitmore-Fenske type, should be used in order to obtain the enol acetate free of the heptaldehyde and heptaldehyde diacetate impurities. The checkers used a Whitmore-Fenske type column of about six theoretical plates.
5. The residue consists largely of heptaldehyde diacetate, which when slowly distilled at atmospheric pressure partially decomposes to acetic anhydride and heptaldehyde. In this manner, 50–60% of the available heptaldehyde is recovered from the residue.
6. The checkers recommend a mechanical stirrer to avoid danger of contact with bromine.
7. Commercial methanol (99.5–100%) was used in all experiments.
8. The acetal must be free of acid; otherwise decomposition takes place during distillation.
9. The pure bromoacetal is a stable, colorless liquid, of mild odor. It may be kept indefinitely when stored in a dark bottle over a small amount of anhydrous sodium carbonate.

3. Discussion

The procedure described is an example of a general method of preparation of α-bromoaldehydes.[1] α-bromoheptaldehyde has been prepared by the bromination of heptaldehyde diethyl acetal with phosphorus trichlorodibromide[2] and by direct bromination of heptaldehyde trimer with subsequent treatment with alcohol.[3]

References and Notes

1. Bedoukian, *J. Am. Chem. Soc.*, **66**, 1325 (1944).
2. Kirmann, *Compt. rend.*, **184**, 525 (1927); *Ann. chim.*, (10) **11**, 223 (1929).
3. Dworzak and Pfifferling, *Monatsh.*, **48**, 251 (1927).

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

α-Bromoheptaldehyde

Heptaldehyde enol acetate

α-Bromoheptaldehyde dimethyl acetal

heptaldehyde diacetate

heptaldehyde diethyl acetal

phosphorus trichlorodibromide

hydrochloric acid (7647-01-0)

methanol (67-56-1)

acetic anhydride (108-24-7)

sodium carbonate (497-19-8)

bromine (7726-95-6)

carbon tetrachloride (56-23-5)

carbon dioxide (124-38-9)

potassium acetate (127-08-2)

Enanthaldehyde, α-bromo- (16486-84-3)

methyl acetate (79-20-9)

heptaldehyde (111-71-7)