

Room-temperature Reactions of CsSO₄F with Organic Molecules containing Heteroatoms

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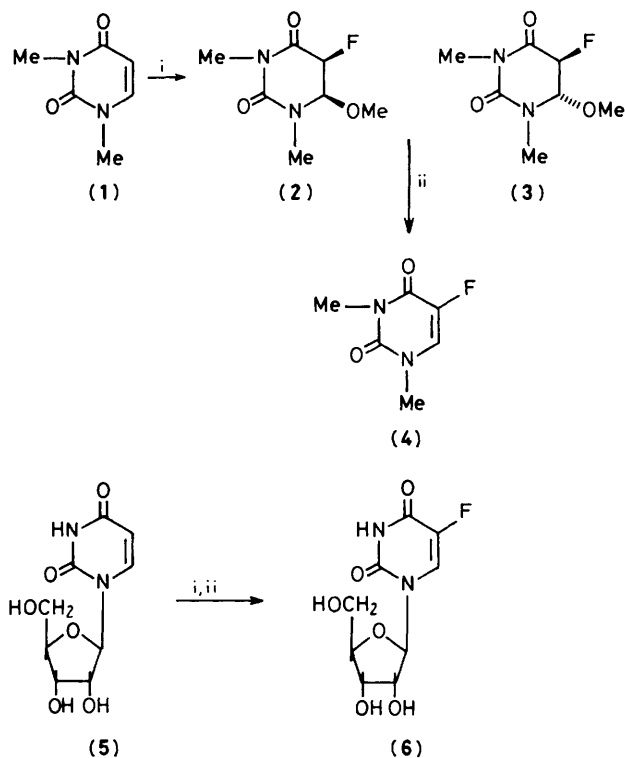
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Room-temperature fluorination of pentane-2,4-dione with CsSO₄F gave 3-fluoro and 1,3-difluoro derivatives, while 5,5-difluorobarbituric acid was formed in high yield in a 2 h reaction at 100 °C; 1,3-dimethyluracil was converted in methanol *via cis*- and *trans*-5-fluoro-6-methoxy derivatives into 5-fluoro-1,3-dimethyluracil in high yield and uridine into 5-fluorouridine.

Many efforts have been made in recent years to find reagents which are able to introduce a fluorine atom into organic molecules under mild conditions. Fluoroxy compounds and in particular CF₃OF,¹ represent a class of reagents which have been used with varying degrees of success, while Rozen and co-workers² made an important improvement by using fluoroxy compounds prepared by fluorination of MeCO₂Na and CF₃CO₂Na with elemental fluorine. Recently, Appelman and co-workers³ have synthesized the first example of ionic hypofluorite, and CsSO₄F has already been shown to be able

to introduce a fluorine atom into aromatic molecules⁴⁻⁶ and alkenes⁷ at room temperature.

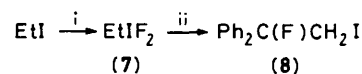
We now report that CsSO₄F reacts with various organic molecules containing heteroatoms. Stirring for 1 h of an acetonitrile suspension containing 1 mmol of CsSO₄F and 1 mmol of pentane-2,4-dione at room temperature gave a reaction mixture containing 0.44 mmol of 3-fluoropentane-2,4-dione and 0.19 mmol of 1,3-difluoropentane-2,4-dione (as determined by ¹⁹F n.m.r. spectroscopy with C₆F₆ as internal reference), indicating that transfer of the fluorine atom into the



Scheme 1. i, CsSO₄F, MeOH; ii, Et₃N, MeOH, H₂O.

substrate amounted to 82%. Increasing the amount of CsSO₄F resulted in increased formation of the difluoro product, and in the case of a twofold excess of the reagent, the two products (formed in the ratio 1.4:1) were also accompanied by 2% of 3,3-difluoropentane-2,4-dione, while the efficiency of fluorine atom transfer was lowered to 70%. These results indicate a different reactivity compared to other fluorinating agents, *e.g.* XeF₂ led to the formation of 3,3-difluoropentane-2,4-dione.⁸ Room-temperature reaction with barbituric acid failed, while heating for 2 h of a reaction mixture containing 2.13 mmol of CsSO₄F and 1 mmol of barbituric acid in 4 ml of acetonitrile in a sealed glass tube at 100 °C gave a reaction mixture containing 0.81 mmol of 5,5-difluorobarbituric acid.

Reaction of CsSO₄F with 1,3-dimethyluracil (1) in acetonitrile at room temperature resulted in small amounts of 5-fluoro-6-hydroxy-1,3-dimethyl-5,6-dihydrouracil and 5-fluoro-1,3-dimethyluracil, while reaction for 1 h in methanol at room



Scheme 2. i, 2CsSO₄F, MeCN; ii, Ph₂C=CH₂.

temperature gave a mixture of *cis*- and *trans*-5-fluoro-6-methoxy derivatives (Scheme 1) (2) and (3) in 11.5:1 ratio, which were further converted with triethylamine into 1,3-dimethyl-5-fluorouracil (4) in high yield (89%, after crystallization in methanol). Room-temperature fluorination of uridine (5), followed by treatment with triethylamine gave 5-fluorouridine (6) in high yield (79%, after purification).

CsSO₄F reacted very quickly at room temperature with trimethylchlorosilane (1 mmol) in acetonitrile, forming, after 10 min, 0.45 mmol of trimethylfluorosilane; increasing the reaction time to 30 min increased the amount of trimethylfluorosilane to 0.58 mmol, but then small amounts of other products were detected.

Further, we have studied reactions of CsSO₄F with organic molecules containing heteroatoms which can change their valency states. An acetonitrile solution of ethyl iodide was converted with CsSO₄F into difluoroiodoethane (7) (Scheme 2) whose existence was determined by reaction with 1,1-diphenylethene to give 1,1-diphenyl-1-fluoro-2-iodoethane (8) [2 mmol of CsSO₄F afforded 0.8 mmol of (8)]. Room-temperature reactions of CsSO₄F with dibenzothiophene or triphenylphosphine led only to oxidation.

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