

A Synthesis of Solanone

Yong Tae Kim, Kwang-Kyu Yang, Kun Soo Kim and Sung Chul Shin

Department of Chemistry, Korea Ginseng and Tobacco Research
Institute, 302-345, Daejeon, Korea

(Received Nov. 2, 1988)

솔라논의 합성

김 용 태 · 양 광 규 · 김 근 수 · 신 성 철

한국인삼연초연구소 화학부

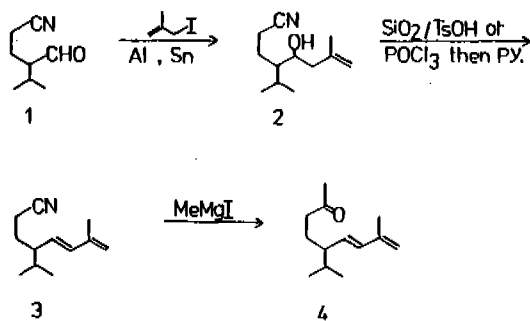
초 록

담배의 중요 향기성분인 솔라논에 관한 전체 합성이 시도되었다. 출발물질인 4-시아노-2-이소프로필부탄알을 금속 주석, 알루미늄 및 브롬산의 존재 하에서 요오드화 메탈릴로 처리하고 포스포러스 옥시클로리드와 반응시킨 다음 메틸화 함으로써 좋은 수득률로 솔라논을 합성하였다.

Abstract

A total synthesis of solanone was investigated. 4-Cyano-2-isopropylbutanal was treated with methallyl iodide in the presence of metallic tin, aluminium and HBr to obtain 7-cyano-5-isopropyl-4-hydroxy-2-methyl-1-heptene, which was contacted with phosphorus oxychloride, followed by methylation of dienitrile, yielded the solanone.

Solanone, 3,4-*trans*-5-isopropyl-2-methyl-8-oxo-1,3-nonadiene (4), a clear, colorless, mobile oil with a faint aroma reminiscent of carrots, arises from the biodegradation of some cembrene-type precursors during the tobacco processing-fermentation, curing, and aging¹⁾. This material, when smoked together with megastigmatrienone, is known to be able to provide a remarkable tobacco flavoring effect²⁾. Although several synthetic methods have appeared in literature, they are not suitable for the practical synthesis of large quantities of this material^{1,3,4)}. In this communication, we describe a novel, useful synthetic route to solanone from 4-cyano-2-isopropylbutanal (1), which is readily available^{1,3)}.



Scheme

Alkylation of starting material 1 with methyl iodide gave 7-cyano-5-isopropyl-4-hydroxy-2-methyl-1-heptene (2) in 80% yield. The reaction was carried out in the presence of metallic tin, aluminium, and catalytic amounts of hydrobromic acid at room temperature in a 1:5 mixed solvent of water/ether overnight. The IR spectrum of the product showed strong hydroxy absorption at 3500 cm^{-1} and typical olefinic peak at 1640 cm^{-1} .

Compound 2 was treated with freshly prepared D'Onofrio's reagent⁵⁾ at room temperature for 1 hr. to give 3,4-*trans*-7-cyano-5-isopropyl-2-methyl-1,3-heptadiene (3) in 50% yield together with a small amount of unidentified compound. When compound 2 was contacted with phosphorous oxychloride at

room temperature for 1 hr. and heated subsequently with pyridine for 30 min., the diene 3 was not contaminated by the above unknown identity and obtained in almost quantitative yield.

The IR spectrum of 3 showed the disappearance of hydroxy absorption. Its ¹H-NMR spectrum displayed C-1, C-3 and C-4 proton signals at 4.90, 6.15 and 5.25 ppm. The coupling constants $J_{3,4}$ and $J_{4,5}$ were in close agreement with those known for the similar compounds.

Finally, compound 3 was reacted with methylmagnesium iodide according to Jonson's method¹⁾ to yield the desired solanone (4) in 66% yield. Compound 4 was identical with an authentic sample prepared in a similar manner as described in the literature^{1,3)}.

Experimental

Thermometers used in this experiments were uncorrected. ¹H-NMR spectra were recorded on Varian FT-80A spectrometer, and the data were given in δ units downfield from TMS. IR spectra were measured with a Varian MAT 212 mass spectrometer. 4-Cyano-2-isopropylbutanal¹⁾ and D'Onofrio's reagent⁵⁾ were prepared by the method described in the literature. Other chemicals and solvents were purchased and used without further purification.

7-Cyano-5-isopropyl-4-hydroxy-2-methyl-1-heptene (2)

To a solution of 100 ml ether-water (5:1) containing a few drops of 50% HBr were suspended Sn (12 g, 0.1 mol), Al (5.4 g, 0.2 mol) and methyl iodide (36 g, 0.2 mol) with stirring. 4-Cyano-2-isopropylbutanal (24 g, 0.2 mol) was added and the mixture was stirred at room temperature for 12 hr.. The organic layer was separated, washed with 10% aqueous NaHCO_3 , and evaporated, yielding the crude product, which was distilled fractionally to give 31 g (80%) of pure 2: bp_{2 mmHg} 127-129°C; ¹H-NMR (CDCl_3 , TMS) 4.83 (d, 2H, $J=9\text{Hz}$), 3.8 (m, 1H), 1.78 (s, 3H), 0.98 (d, 3H, $J=$

7Hz), and 0.88(d,3H,J=7Hz); IR(nujol) 3500,2900, 1640,and 1370⁻¹; MS(m/e) 195(M⁺).

3,4,-trans-7-Cyano-5-isopropyl-2-methyl-1,3-heptadiene (3)

method A: To 50g of D'Onofrios' reagent was added 200ml of the benzene solution of compound (20g, 0.1ml) in small portions with well stirring. After stirring at room temperature overnight, the resulting mixture was extracted with CH₂Cl₂, and evaporated, yielding the crude product, which was distilled fractionally to give 9g(50%) of pure 3: bp_{3.5 mmHg}111-114°C: ¹H-NMR(CDCl₃, TMS) 6.15(d,1H,J=16Hz), 5.25(dd,1H,J=16,8Hz), 4.90(br s,2H) 1.80(s,3 H), 0.90 (d,3H,J=7Hz), and 0.85(d,3H,J=7Hz): IR (nujol) 2900,2220,1600, and 1370cm⁻¹; MS(m/e) 177 (M⁺).

method B: Compound (20g, 0.1mol) was added to phosphorus oxychloride (32g, 0.2mol) in small portions with stirring. The mixture was stirred at room temperature for 1hr., and pyridine (20ml) was

added. The mixed solution was refluxed for 30min. and allowed to cool to room temperature. Water was added, and the resulting solution was extracted with CH₂Cl₂. The CH₂Cl₂ layer was washed with 10% aqueous NaHCO₃, dried over MgSO₄, and evaporated. The crude product was purified by a similar method to give 18g (100%) of 3.

References

1. R.R.Jonson, and J.A.Nicolson, J.Org. Chem., *30*, 2918(1965).
2. R.A.Willson, B.D.Mookherjee, and J.F.Vinals, Tobacco Research, *42*(1983); T.Fujimori, and H.Kaneko, Nippon Nogeikagaku Kaishi *53*, R95 (1979).
3. US Patent 4,412,083(1983); E.Demole, and C. Demole, Helv. Chim. Acta, *58*, 1857(1975).
4. A.Kohda, and J.Sato, J.Chem. Soc., Commun., 915(1981).
5. F.D'Onofrio, and A.Scettri, Synthesis, 1159 (1985).