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Studies on the Syntheses of Heterocyclic Compounds. CCXXXVIII.[1) A Modified Synthesis of Pummerer's Ketone

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It has been well known that phenol oxidation of *p*-cresol with potassium ferricyanide in an alkaline solution afforded the Pummerer's ketone (I).[3–5)

In case of the previous reports an aqueous solution was mainly used as solvent, and therefore separation of the reaction products was not so convenient. We hereby wish to report a modified procedure for the synthesis of I, in which the yield of I was improved by using liquid ammonia as solvent.

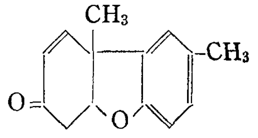

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Chart 1

To a stirred suspension of one molar equivalent of sodium amide was added an equivalent mole of *p*-cresol. After a few minutes a powdered potassium ferricyanide was added rapidly to the above solution. After concentration of ammonia with stirring, the residue was treated with an equivalent mole of ammonium chloride and the residual ammonia was then evaporated to dryness to give a product which was confirmed as Pummerer's ketone (I), mp 124—125°.[1) The spectral data (IR and NMR) and mixed melting point test support the structure of I to be correct. Molar ratio of reagents and yield of I are summarized in Table I.

Table I. The Yield of Pummerer's Ketone

p-Cresol used g (mole)	$K_3[Fe(CN)_6]$ used g (mole)	Yield of Pummerer's ketone g (%)	*p*-Cresol recovered g (%)
10 (0.1)	26.5 (0.08)	1.15 (11.7)	2.5 (25)
10 (0.1)	33.0 (0.10)	2.1 (20.5)	1.3 (13)
10 (0.1)	50 (0.15)	2.8 (28.5)	none
10 (0.1)	66 (0.20)	2.6 (26.5)	none

Thus, the yield of I was found to be improved by using liquid ammonia as solvent on comparison with that of Waters' procedure.[5) Furthermore, 1.5 molar equivalent of oxidation reagent was found to be satisfied for the formation of I. In addition, since the treatment after reaction is very easy and ammonia is a good solvent for organic compounds, application of this procedure to the other insoluble material in water seems to be convenient.

Experimental

Pummerer's Ketone (I)——To a stirred suspension of 2.3 g (0.1 mole) of meltallic sodium in 300 ml of liq. NH_3 was added 10 g (0.1 mole) of *p*-cresol. After 5 min, 50 g (0.15 mole) of powdered $K_3[Fe(CN)_6]$ was added rapidly to the above mixture, which was then evaporated with stirring to give *ca.* 50 ml of the residue.

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1) Part CCXXXVII: T. Kametani, K. Ohkubo, and S. Takano, *Chem. Pharm. Bull.* (Tokyo), **16**, **1095** (1968).
2) Location: *No. 85, Kita-4-bancho, Sendai.*
3) D.H.R. Barton, A.M. Delforin, and D.E. Edwards, *Chem. Ind.* (London), **1955**, 1039.
4) D.H.R. Barton, A.M. Delforin, and D.E. Edwards, *J. Chem. Soc.*, **1956**, 530.
5) C.G. Haynes, A.H. Turner, and W.A. Waters, *J. Chem. Soc.*, **1956**, 2823.

After 5 g (0.1 mole) of NH_4Cl had been added, stirring was continued until all of the residual liq. NH_3 was evaporated to afford the residue, which was extracted with hot benzene several times. The extract was washed with water, 1N NaOH aq. solution, and water, dried over $CaCl_2$, and evaporated to give a brown residue, which was again extracted with hot *n*-hexane. Removal of the solvent afforded 2.8 g (28.5%) of the ketone (I) as colorless plates. Furthermore purification by silica gel chromatography using benzene as eluent gave the pure ketone, mp 124—125° (lit.,[6] mp 124—125°), whose IR and NMR spectra were completely identical with those of an authentic sample. Mixed melting point test also supports our product to be I.

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Coumarins from the Root of *Angelica gigas* NAKAI

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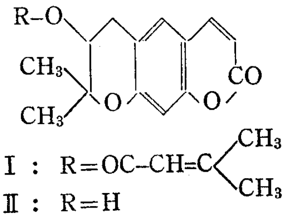
As a part of our continuing study of the coumarins from the Umbelliferous plants, we have investigated the root of *Angelica gigas* NAKAI which is used as "Danggui (当帰)" in Korea. The ether extract of the dried root of this plant upon chromatography over silica gel followed by elution with chloroform afforded a crystalline compound, $C_{19}H_{20}O_5$(I), mp 111°, and the column upon elution with a mixture of *n*-hexane and ethyl acetate (1:1) yielded another crystalline compound, $C_{14}H_{14}O_4$(II), mp 178°.



The coumarin character of the compound I was suggested by the fluorescence under filtered ultraviolet light. The IR and NMR spectra of the compound I, noted under Experimental, were identical with those of decursin, a new coumarin isolated previously from the root of *Angelica decursiva* FR. et SAV. whose structure was elucidated as 3′-hydroxy-3′,4′-dihydroxanthyletin senecioate.[2] From this fact and the mixed melting point deter-

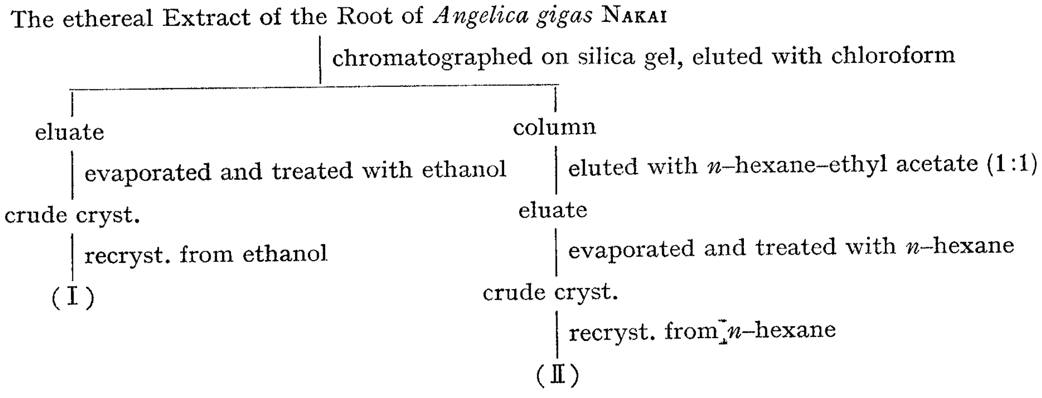


Chart 1. Isolation of the Compounds

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[1] Location: *Shimoadachi-cho, Sakyo-ku, Kyoto.*
[2] K. Hata and K. Sano, *Tetrahedron Letters*, **1966**, 1461.